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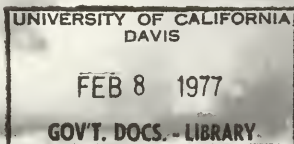






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# Rainfall Analysis for Drainage Design Volume III. Intensity-Duration-Frequency Curves

Bulletin No. 195  
October 1976

Technical Report Documentation Page

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16. Abstract This report is an analysis of depth-duration-frequency of precipitation in California and contains the annual series extreme values from about 30 rain gage networks in California. A statistical analysis of each record is available, giving 12 return periods ranging from 2 to 10,000 years and durations of 5 minutes to 60 days, including the annual total precipitation. Methods of interpolation are given. Hourly precipitation records of the National Weather Service were reevaluated to develop 5-, 10-, 15-, and 30-minute extreme data.  This volume contains precipitation intensity-duration-frequency curves from 500 recording rain gages, based on maximum annual rainfall depths for 5 to 180 minutes.  The information contained in this report is intended for use in runoff computation using procedures such as the rational method or the unit hydrograph method.  A cooperative computer data bank has been developed to store data on rainfall extremes and to periodically analyze data, as well as to maintain a continuous file for future use by cooperators.			
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**Department of  
Water Resources**

**Bulletin No. 195**

# **Rainfall Analysis for Drainage Design**

**Volume III.  
Intensity-Duration-Frequency Curves**

**October 1976**

**Claire T. Dedrick**  
Secretary for Resources

**Edmund G. Brown Jr.**  
Governor

**Ronald B. Robie**  
Director

**The Resources  
Agency**

**State of  
California**

**Department of  
Water Resources**

OTHER VOLUMES OF BULLETIN NO. 195  
(Bound separately)

Volume I. Short-Duration Precipitation Frequency  
Data

Volume II. Long-Duration Precipitation Frequency  
Data

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Kern County Water Agency  
Los Angeles County Flood Control District  
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Marin Municipal Water District  
Monterey County Flood Control and Water Conservation District  
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Riverside County Flood Control and Water Conservation District  
Sacramento County, Department of Public Works  
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University of Nevada, Desert Research Institute  
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U. S. Bureau of Reclamation  
U. S. Forest Service  
U. S. Geological Survey  
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U. S. National Weather Service  
Ventura County Flood Control District  
and many private individuals



Typical modern tipping bucket rain gage  
*Photo by Weather Measure Corp.*

## INTRODUCTION

Bulletin No. 195, *Rainfall Analysis for Drainage Design*, is published as three separate volumes that complement one another but may be used independently, as well. Volume I contains short-duration precipitation data. Volume II contains long-duration precipitation data. This volume, Volume III, presents intensity-duration-frequency (IDF) curves for stations with data for precipitation periods of 5 minutes to 24 hours.

The IDF curves are arranged first by county, second by watersheds within each county, and then alphabetically by station name. The drainage basins are depicted on Plate 1. Individual station locations are plotted on Plate 2. Mean annual precipitation is shown on Plate 3.

The data in this volume consist of annual extremes of rainfall for durations of 5 to 180 minutes (reported in Volume I, along with the analysis on which the curves are based). This information is necessary to the design of culverts, spillways, and other drainage facilities. The sizes of such structures are determined by many factors, including the expected rainfall intensities associated with given return periods. These curves have been developed specifically for culvert designers of the California Department of Transportation who need data on rainfall intensity to estimate runoff at culvert sites. The curves are planned for use with simple runoff models, such as the rational formula:

$$Q = 1.008 CiA \quad (a)$$

where  $Q$  = peak runoff in cubic feet per second

$C$  = runoff coefficient, ranging from "0" for no runoff to "1" for runoff of all rainfall

$i$  = rainfall intensity in inches per hour

$A$  = area in acres

Rainfall intensities are inversely proportional to time; the shorter the period of time, the higher the intensity. Therefore short-duration rainfall is the most critical in culvert design. Short-duration rainfall extremes can be estimated by use of the following equation:

$$I = \bar{P}T^N \quad (b)$$

where  $I$  = design storm intensity, in inches per hour

$\bar{P}$  = mean one-hour storm, as a fraction of MAP, in inches

$T$  = time in hours

$N$  = slope of the log-intensity/log-line plot

Design rainfall for various return periods can be developed from the following equation:

$$I_j = \text{MAP } \bar{P} (1 + K_j \text{CV}) \quad (c)$$

where  $j$  refers to return period

$I_j$  = precipitation intensity for return period  $j$

MAP = mean annual precipitation, in inches (see Plate 3)

$\bar{P}$  = mean one-hour storm, as a fraction of MAP, in inches (see Plate 4)

$K_j$  = frequency factor (see Table 1)

CV = coefficient of variation (see Figure 1)

Combining equations (b) and (c) yields the equations of the IDF curves of Volume III:

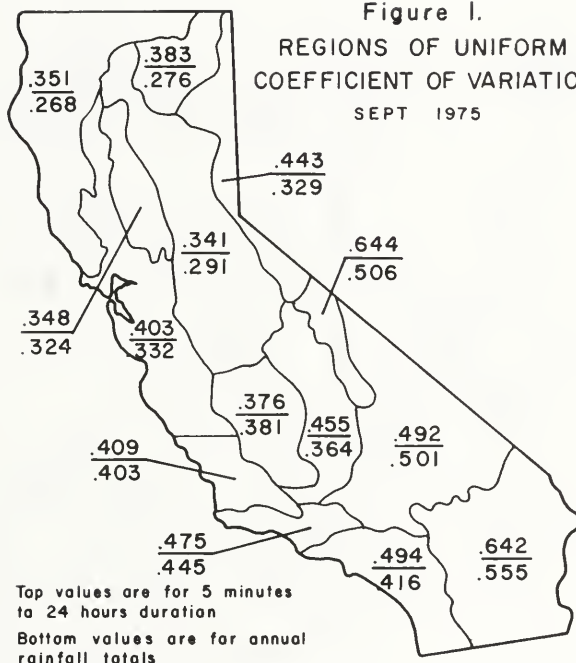
$$K_j = (\text{MAP}) (\bar{P}) (1 + K_j \text{CV}) T^{-n} \quad (d)$$

$K_j$  is the only value representing different return periods; therefore, the lines on the IDF curves are parallel. The distance between the lines are a function of CV and  $K_j$  only. The slope of the IDF curves represents the ratio of short-duration design storms to storms of longer duration

The length of the time period used in a specific application depends on the "time to peak", or time of concentration, which is unique to each watershed. The broad ranges of time represented here are suitable for all but the smallest watersheds. Rooftop and bridge surfaces frequently need data for durations shorter than 5 minutes. No adequate data are available for storms of that duration at the present time; however, estimates of such durations can probably be made from a straight line extension of the IDF curves in this volume.

In some cases, there was no information on one or more of the seven durations of 5, 10, 15, 30, 60, 120, and 180 minutes. Where this has occurred, only those durations that were available were used in this analysis. The durations used are shown on the IDF curves by plotting the mean values just above the two-year return period values.

Figure 1.  
REGIONS OF UNIFORM  
COEFFICIENT OF VARIATION  
SEPT 1975



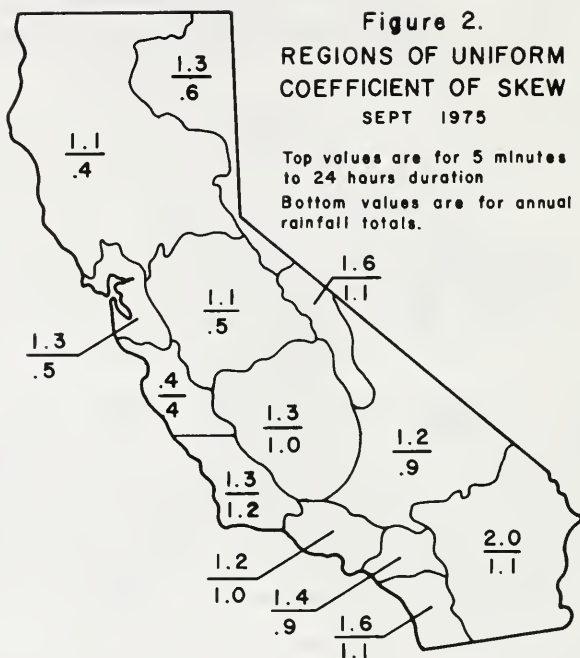


TABLE 1  
FREQUENCY FACTORS FOR PEARSON'S TYPE III DISTRIBUTION

Return Period in Years	Coefficient of Skew																	
	.1	.5	.6	.7	.8	.9	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0	
2	.07	.08	.10	.12	.13	.15	.16	.18	.20	.21	.23	.24	.25	.27	.28	.29	.31	
5	.82	.81	.80	.79	.78	.77	.76	.75	.73	.72	.71	.69	.68	.66	.64	.63	.61	
10	1.32	1.32	1.33	1.33	1.34	1.34	1.34	1.34	1.34	1.34	1.34	1.33	1.33	1.32	1.32	1.31	1.30	
20	1.75	1.77	1.80	1.82	1.84	1.86	1.88	1.89	1.91	1.92	1.94	1.95	1.96	1.97	1.98	1.99	2.00	
25	1.88	1.91	1.94	1.97	1.99	2.02	2.04	2.06	2.09	2.11	2.13	2.15	2.16	2.18	2.19	2.21	2.22	
40	2.14	2.19	2.22	2.27	2.31	2.35	2.38	2.42	2.45	2.49	2.52	2.55	2.58	2.61	2.64	2.66	2.69	
50	2.26	2.31	2.36	2.41	2.45	2.50	2.54	2.58	2.63	2.67	2.71	2.74	2.78	2.81	2.85	2.88	2.91	
100	2.62	2.69	2.76	2.82	2.89	2.96	3.02	3.09	3.15	3.21	3.27	3.33	3.39	3.44	3.50	3.55	3.61	
200	2.95	3.04	3.13	3.22	3.31	3.40	3.49	3.58	3.66	3.75	3.83	3.91	3.99	4.07	4.15	4.22	4.30	
1,000	3.67	3.81	3.96	4.10	4.24	4.39	4.53	4.67	4.81	4.96	5.10	5.23	5.37	5.51	5.64	5.77	5.91	
2,000	3.96	4.12	4.29	4.46	4.63	4.80	4.97	5.13	5.30	5.47	5.63	5.80	5.96	6.12	6.28	6.44	6.60	
10,000	4.60	4.82	5.05	5.27	5.50	5.72	5.96	6.18	6.41	6.64	6.87	7.09	7.32	7.54	7.77	8.00	8.21	







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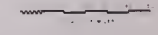




Plate 2 Sheet 2 of 5  
Location of  
RECORDING RAIN GAGES

June 1976

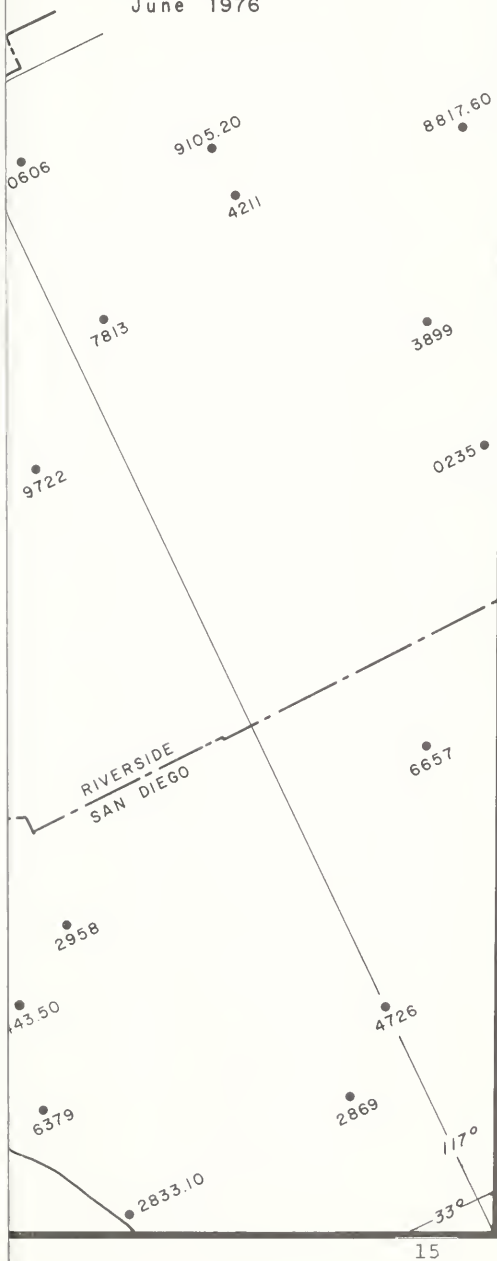














Plate 2 Sheet 3 of 5  
Location of  
RECORDING RAIN GAGES

June 1976

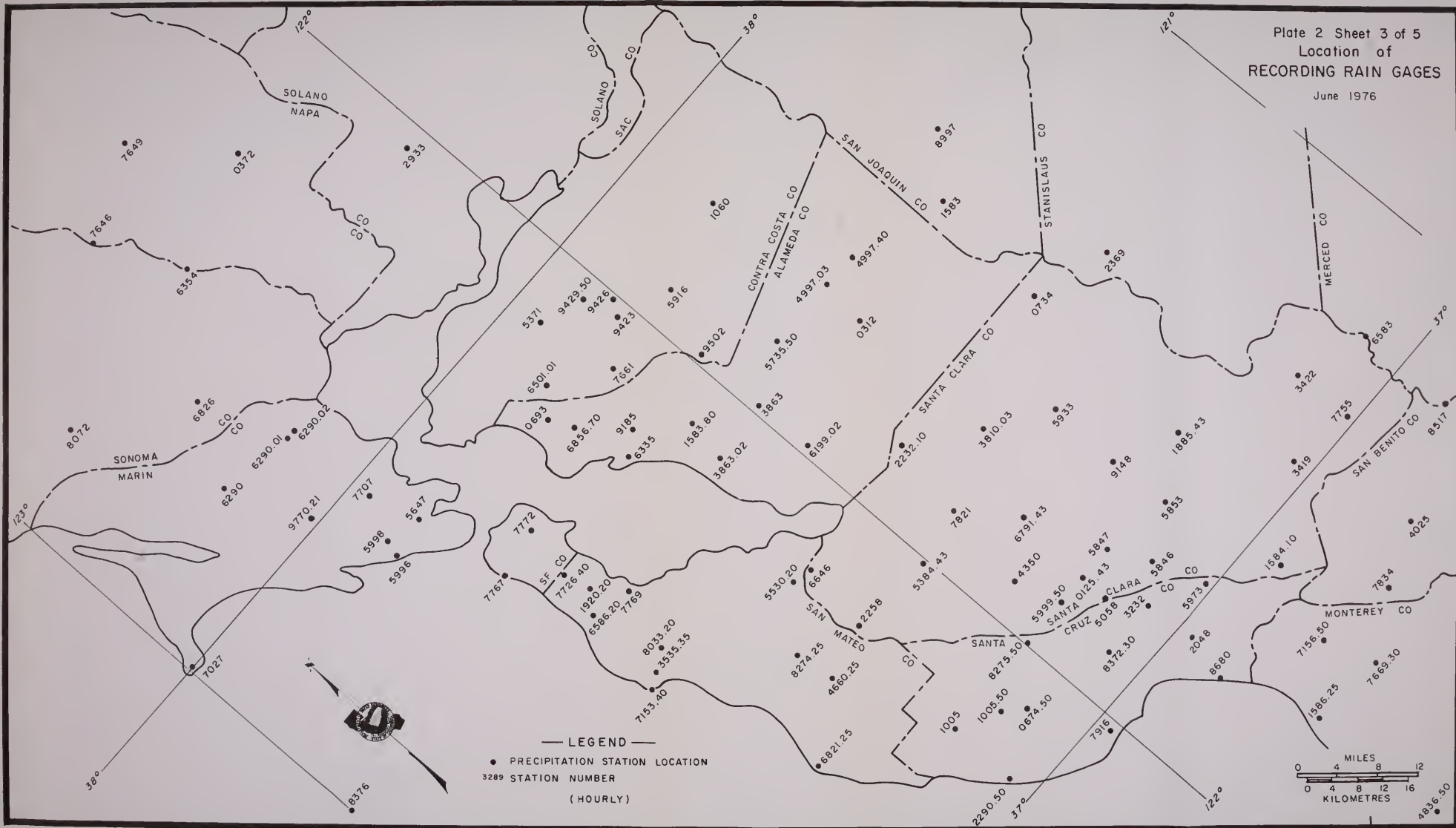




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Location of  
RECORDING RAIN GAGES  
June 1976

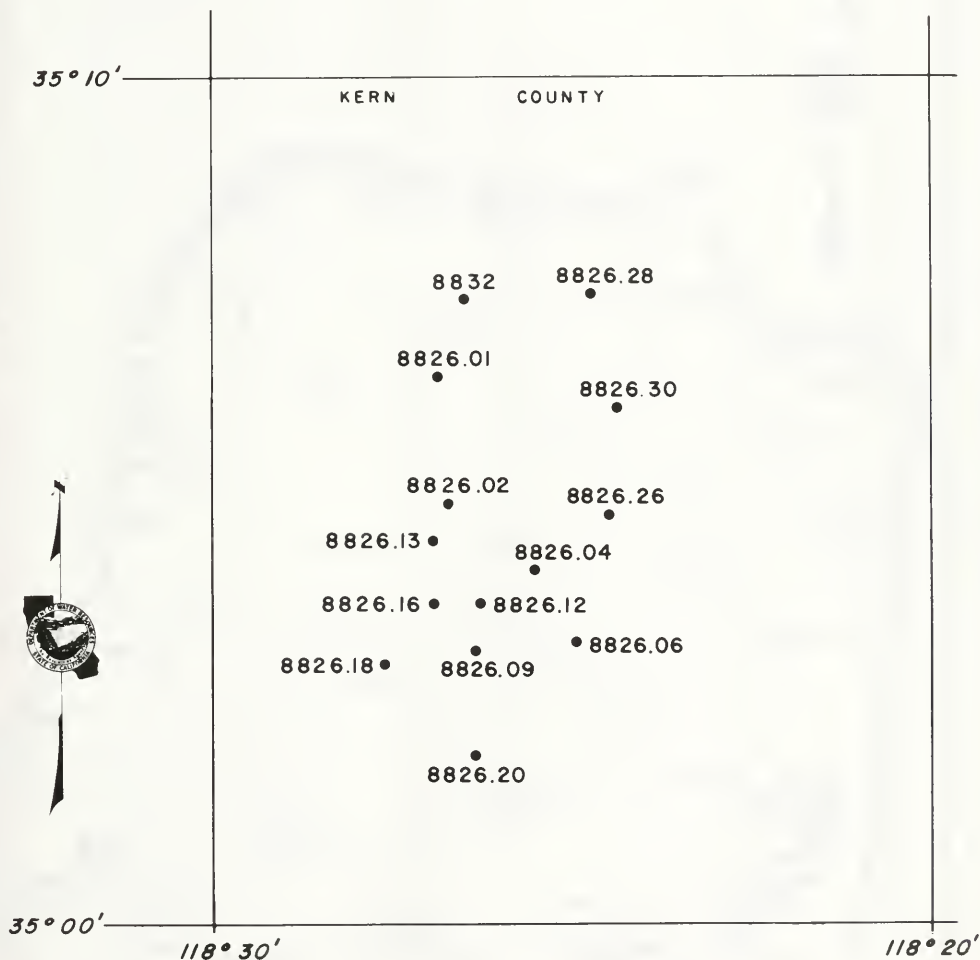


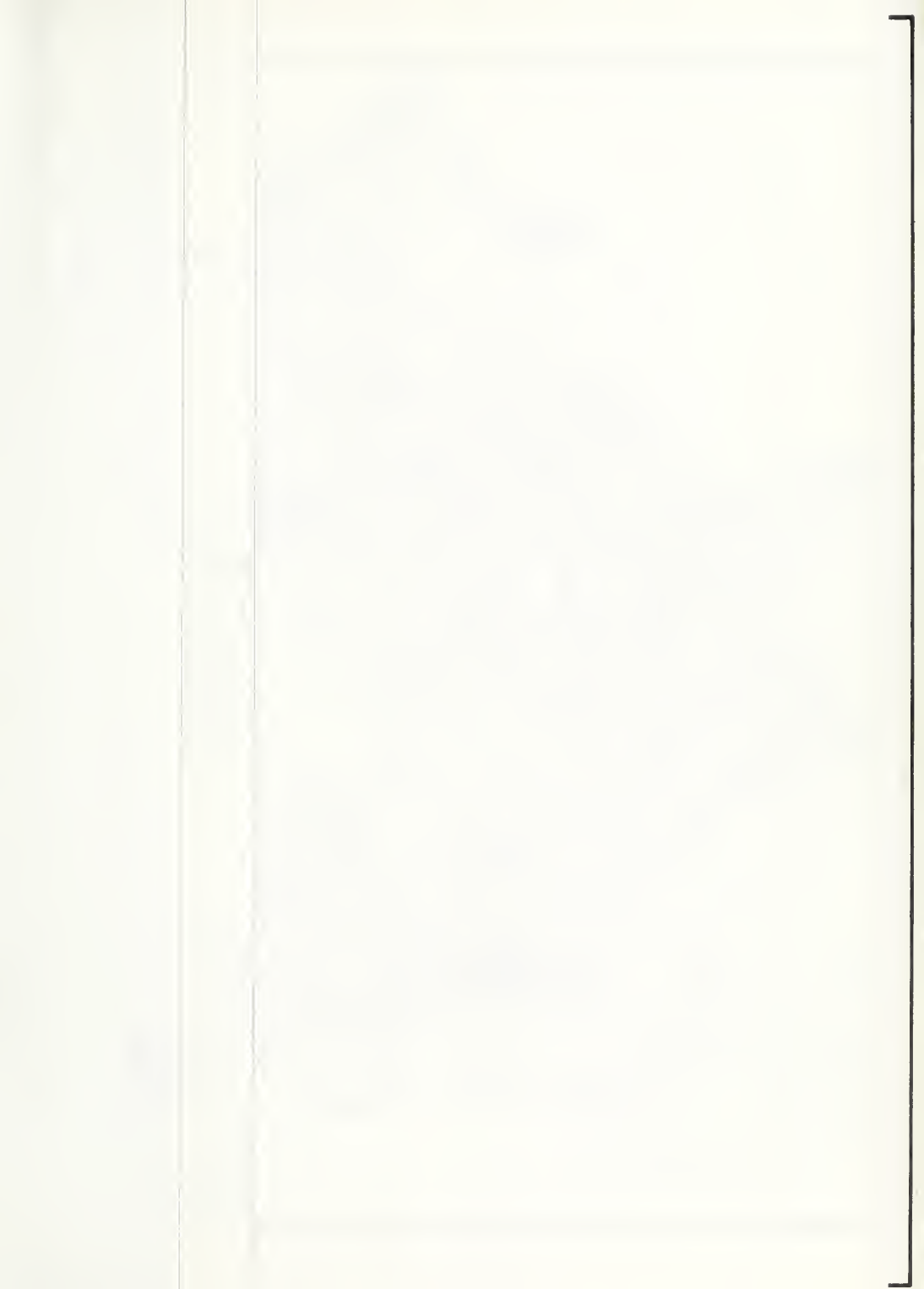
Plate 2 Sheet 5 of 5  
Location of  
RECORDING RAIN GAGES

June 1976

— LEGEND —

- PRECIPITATION STATION LOCATION
- 3289 STATION NUMBER
- ( HOURLY )





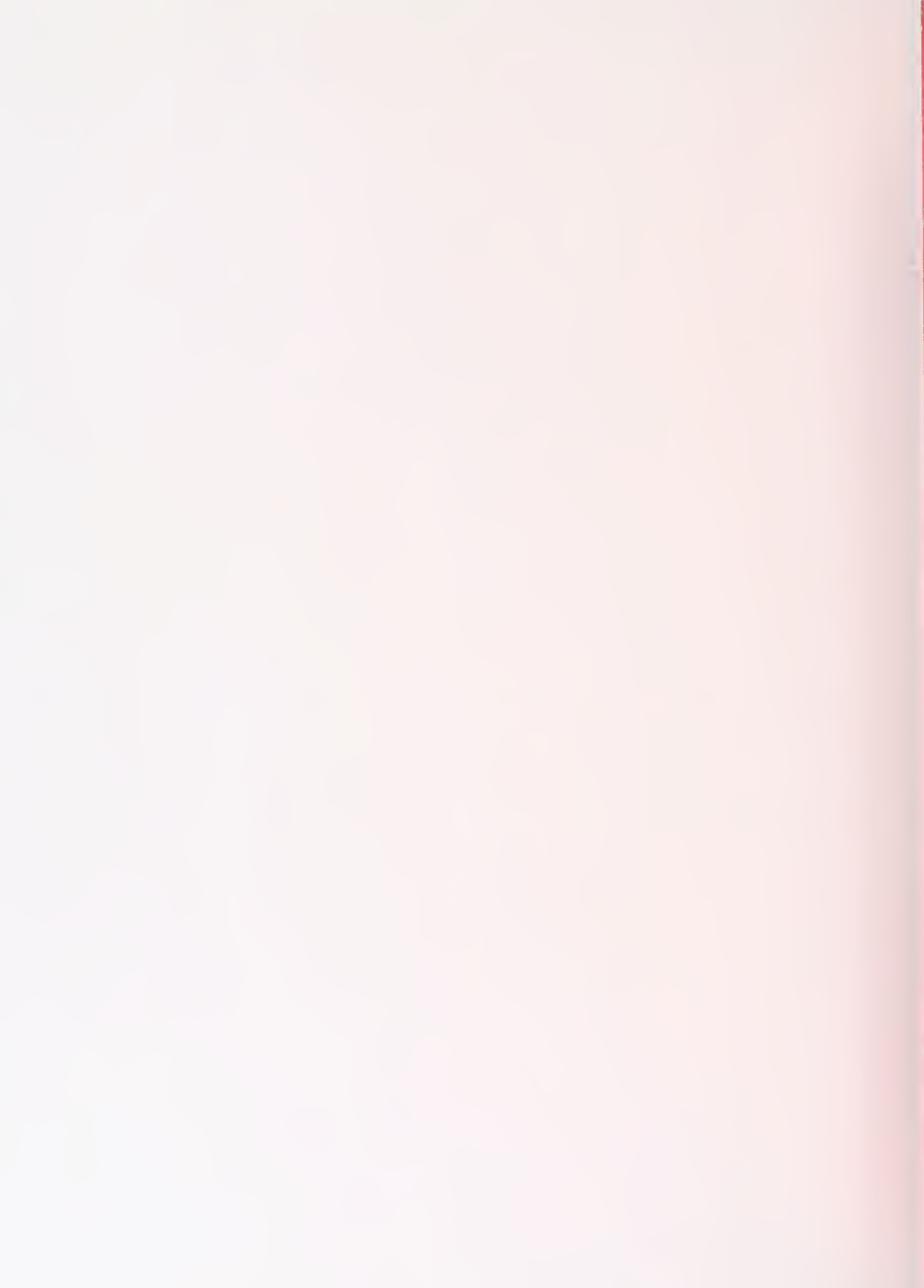
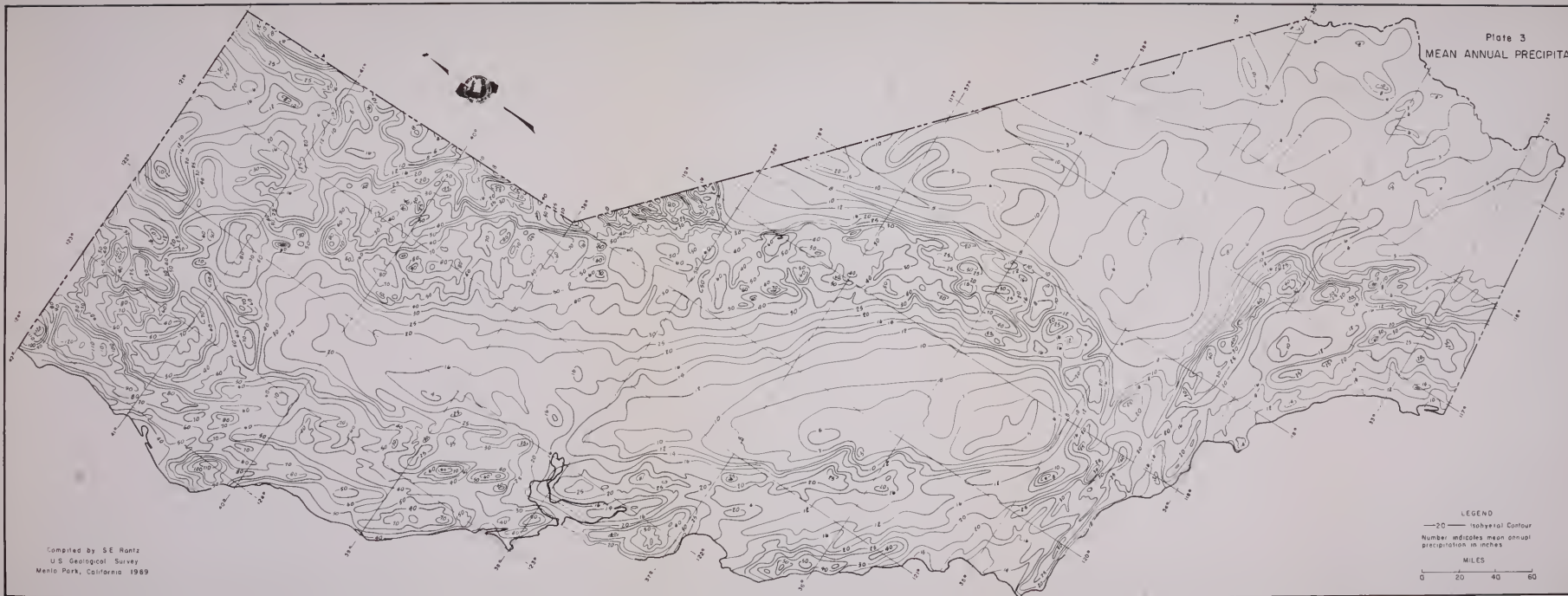


Plate 3  
MEAN ANNUAL PRECIPITATION



Compiled by SE Rantz  
U.S. Geological Survey  
Menlo Park, California 1989

LEGEND  
— Isohyet Contour  
Number indicates mean annual  
precipitation in inches  
MILES  
0 20 40 60





Plate 4  
MEAN ONE-HOUR STORM

Units = fraction of the  
Mean Annual Precipitation

MILES  
0 25 50 75 100

KILOMETRES  
0 50 100 150

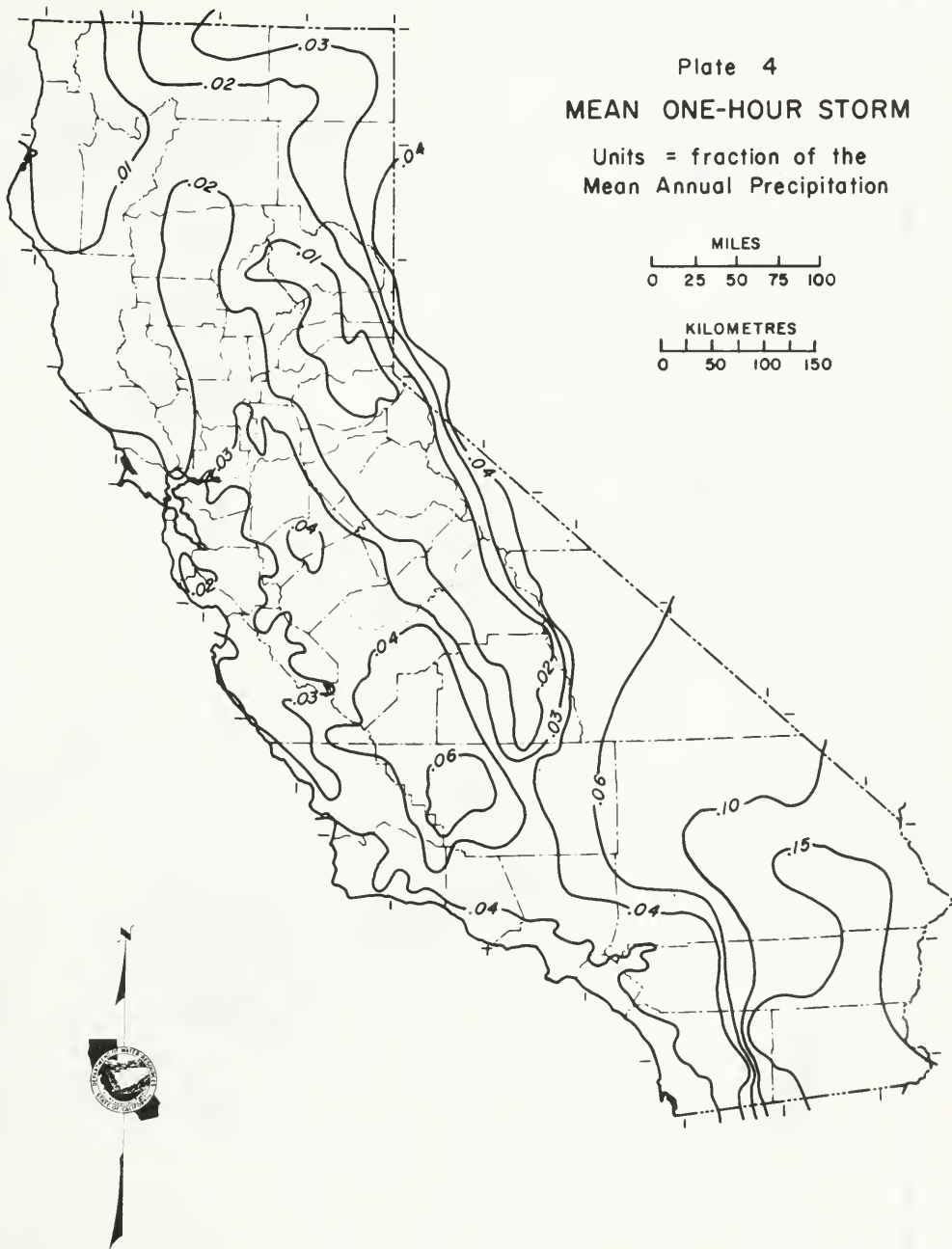
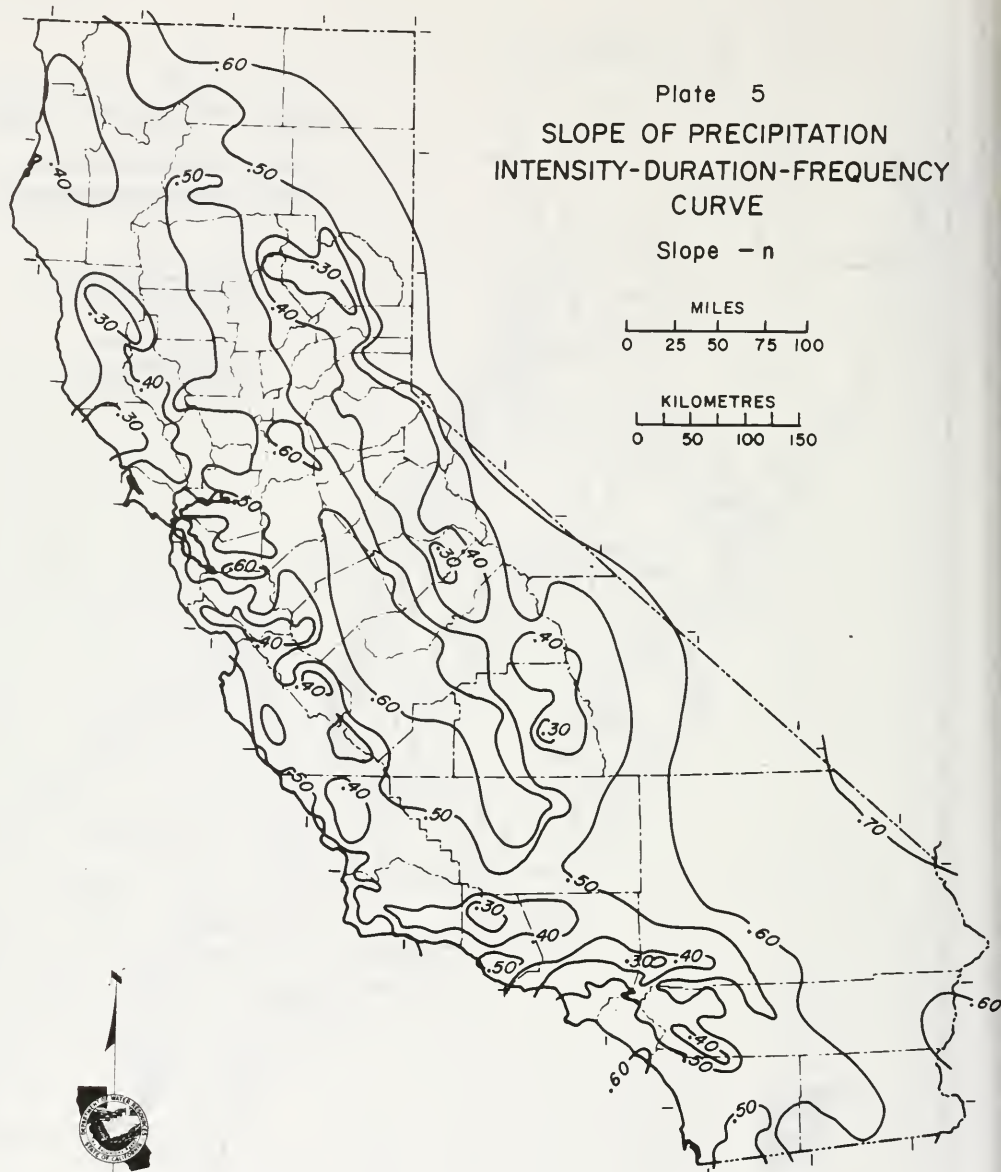


Plate 5  
SLOPE OF PRECIPITATION  
INTENSITY-DURATION-FREQUENCY  
CURVE

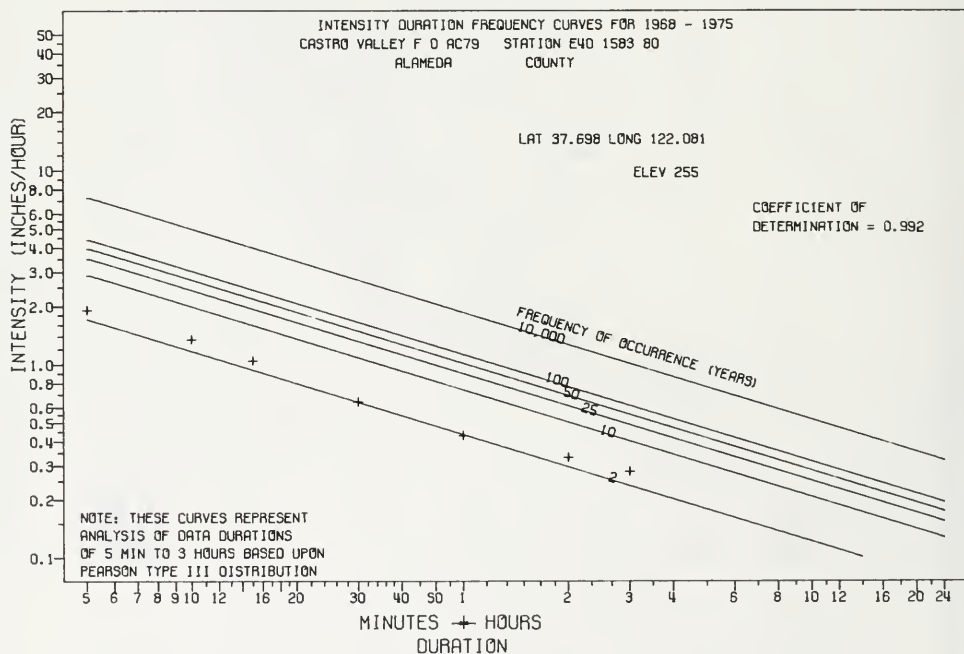
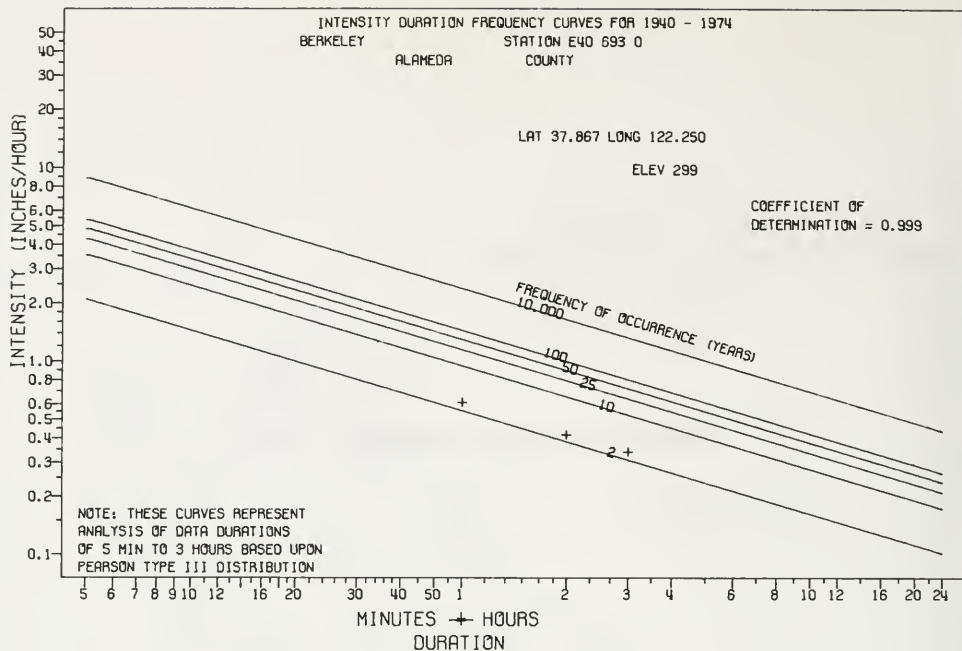
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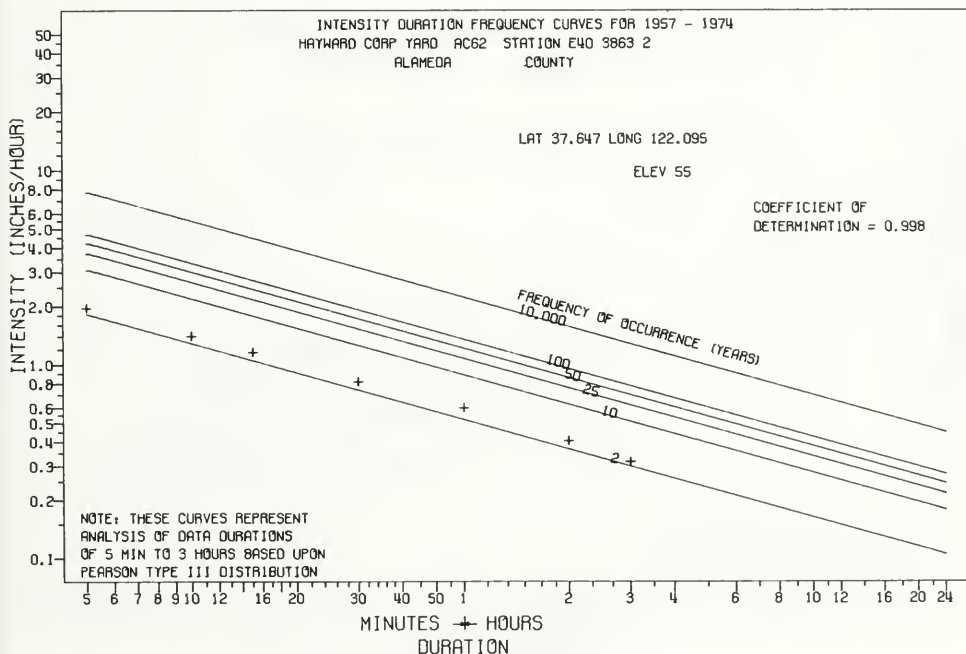
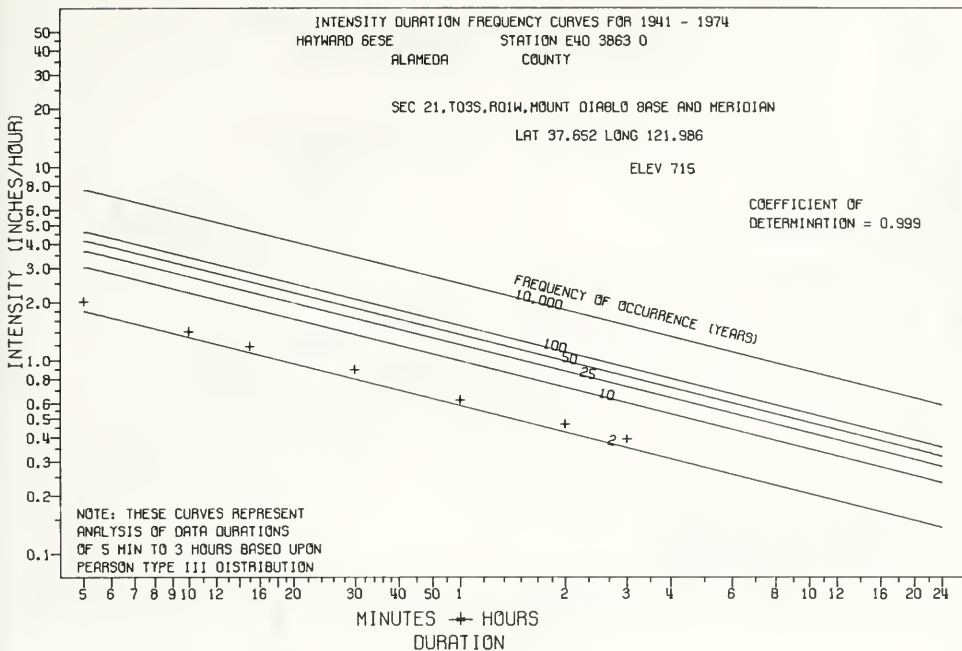
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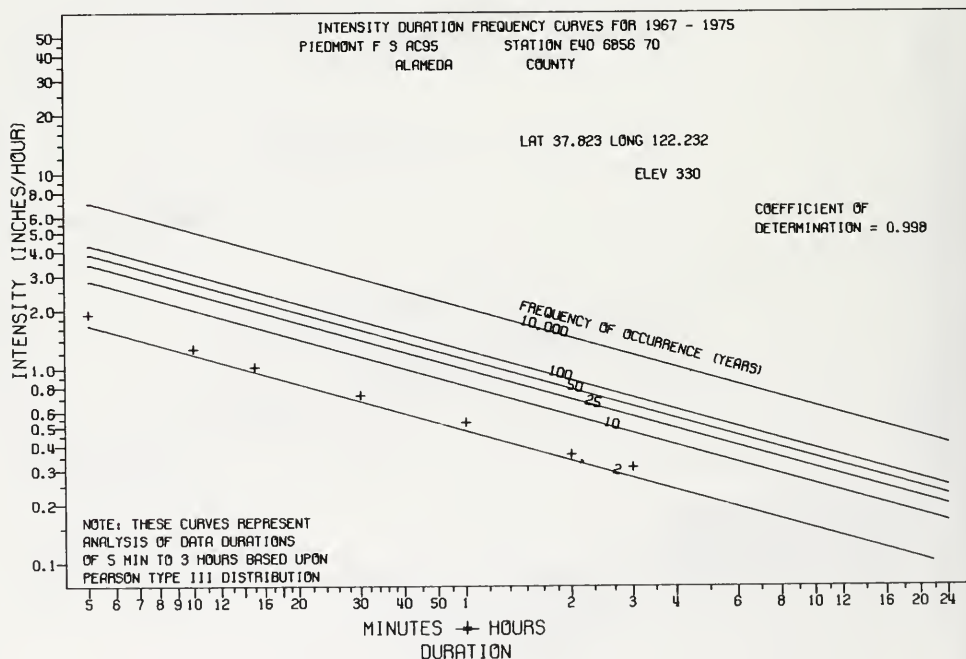
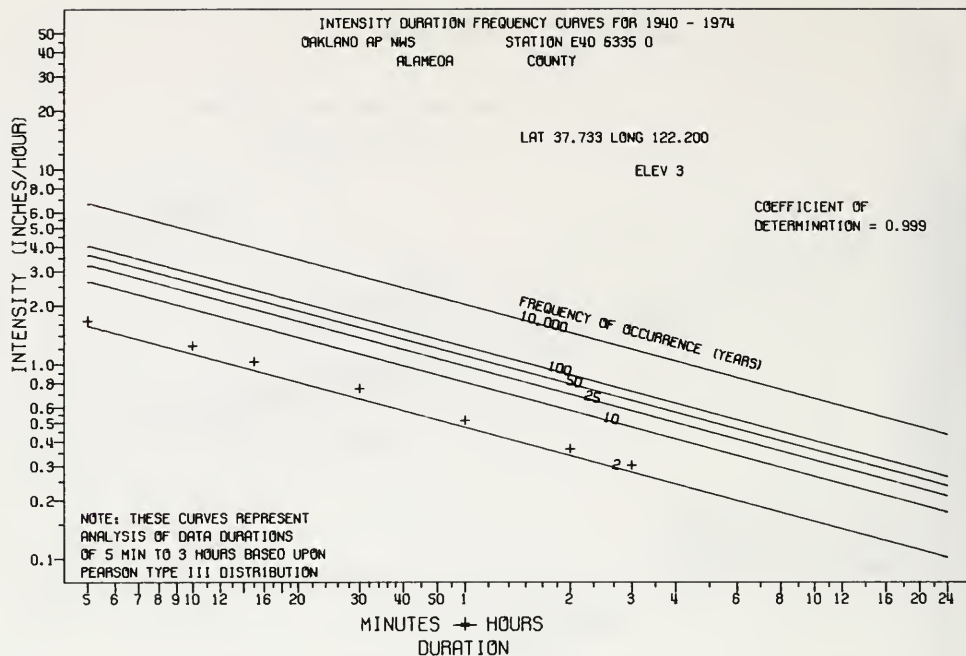
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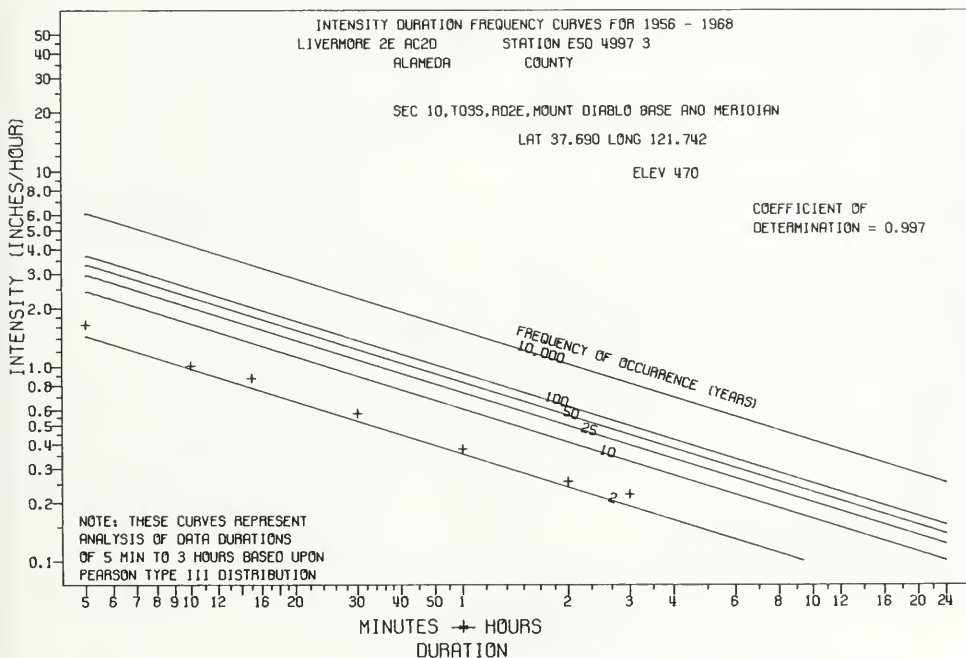
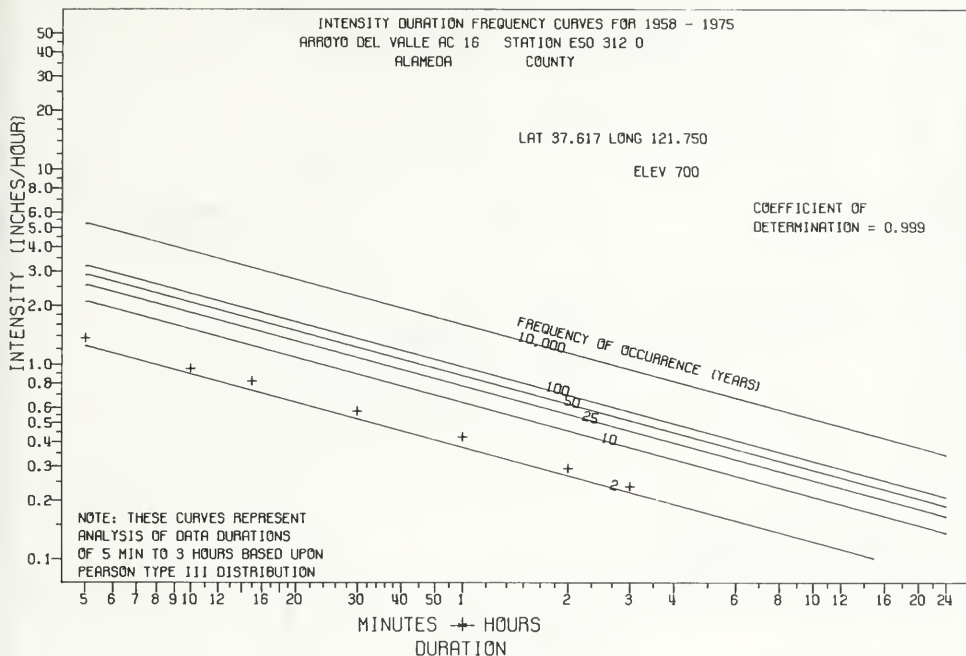


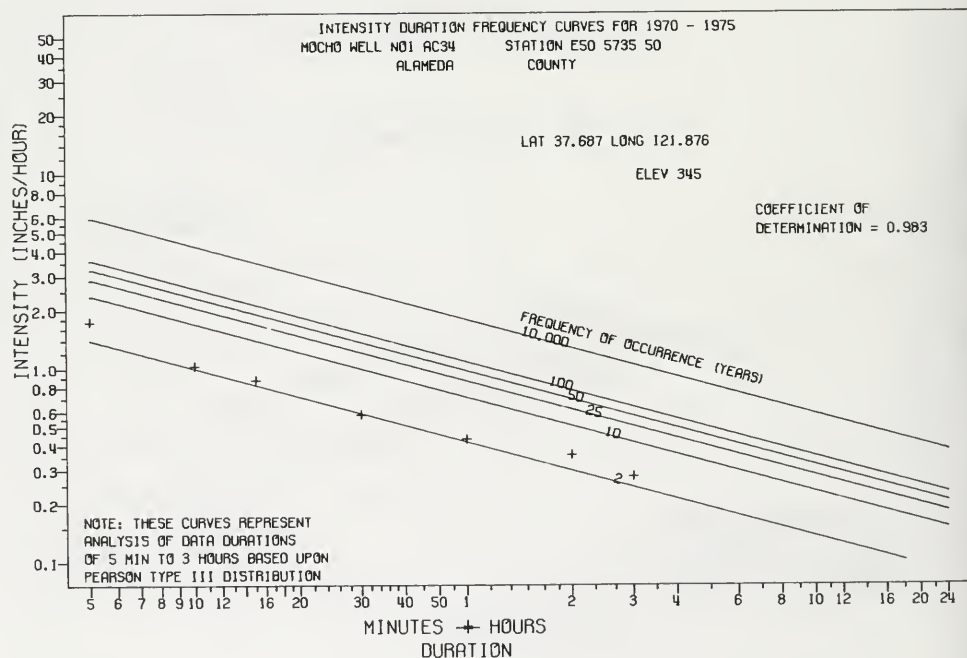
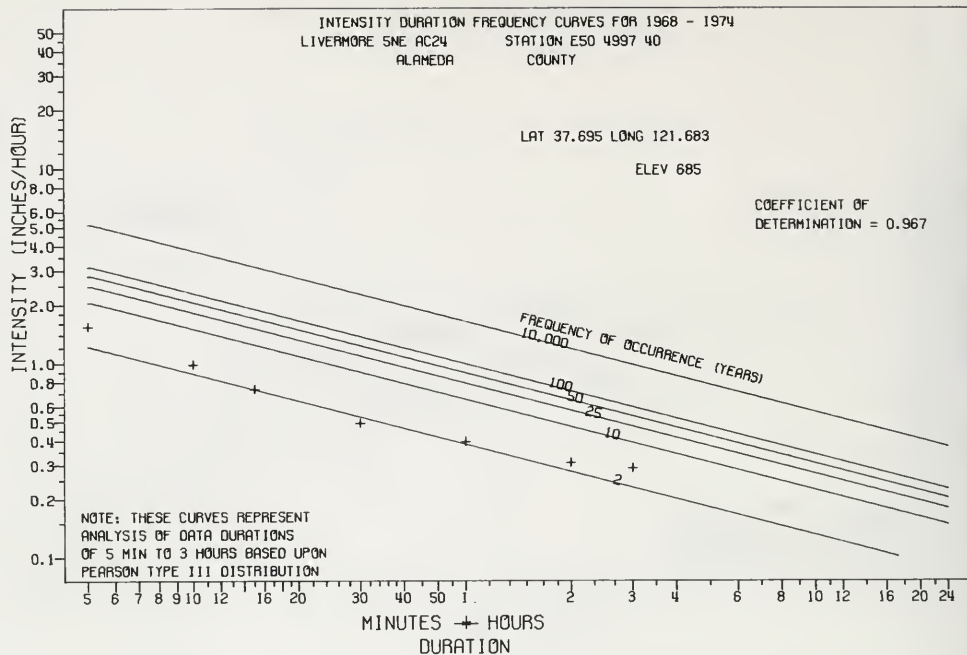
INTENSITY-DURATION-FREQUENCY CURVES



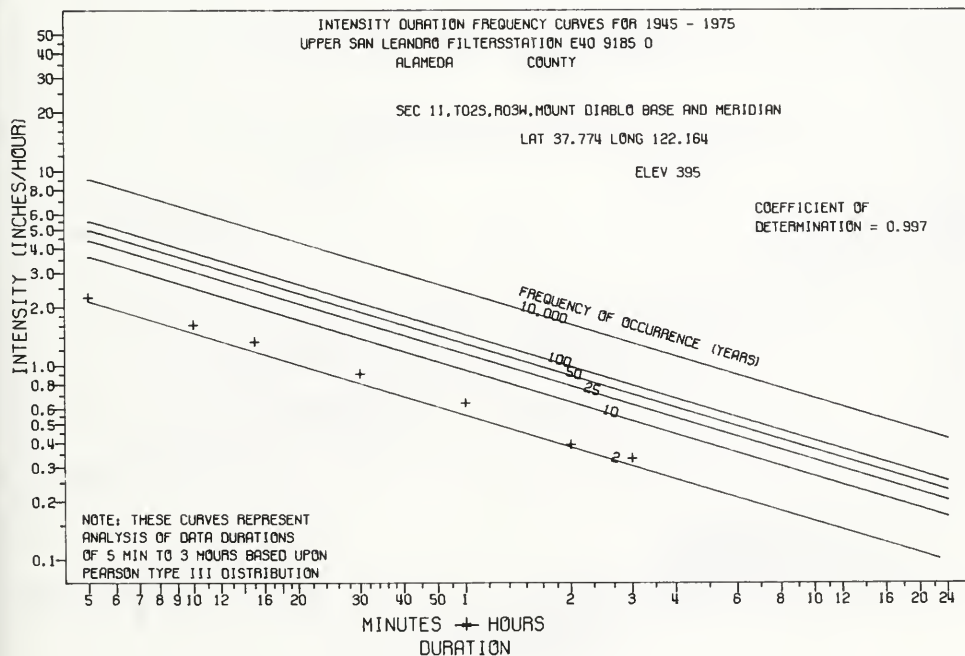
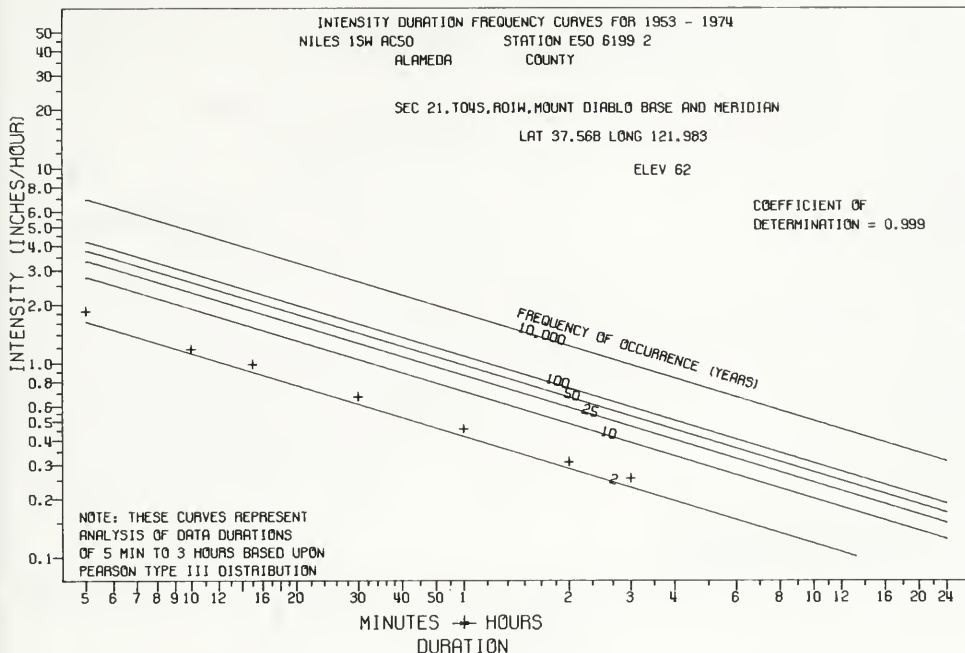


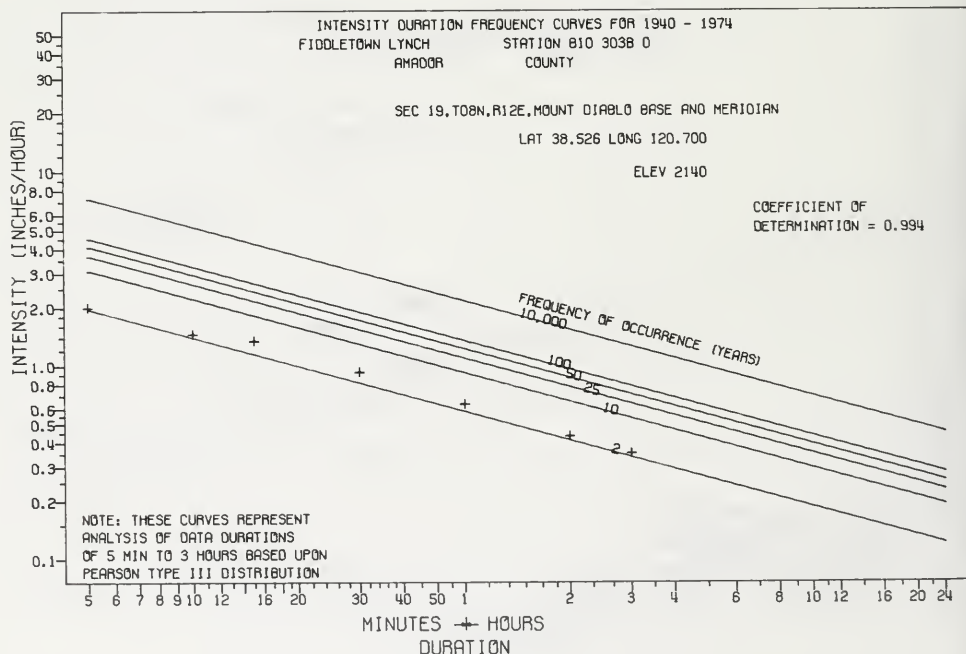
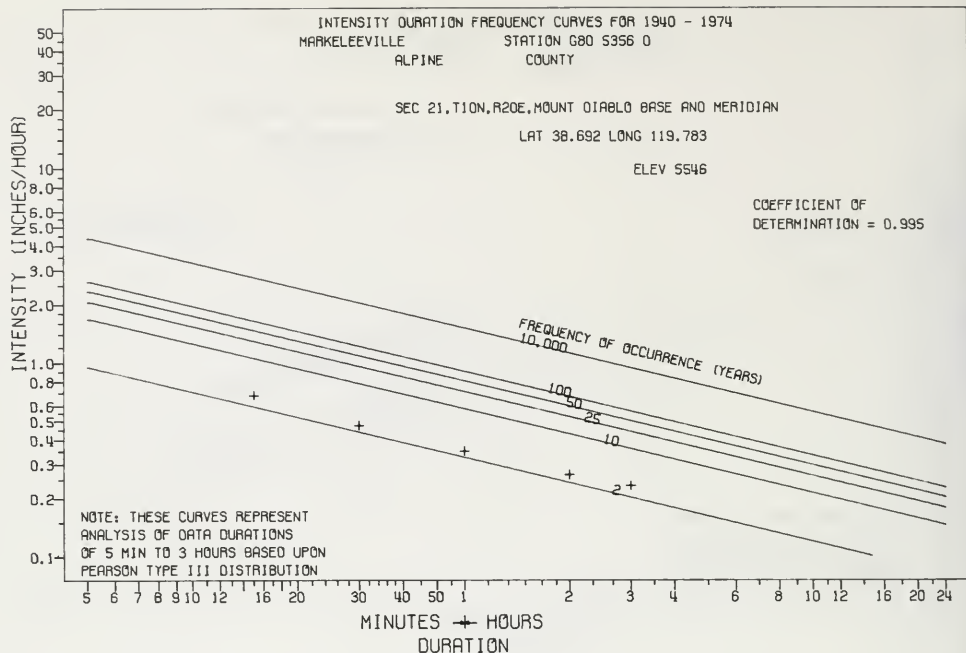


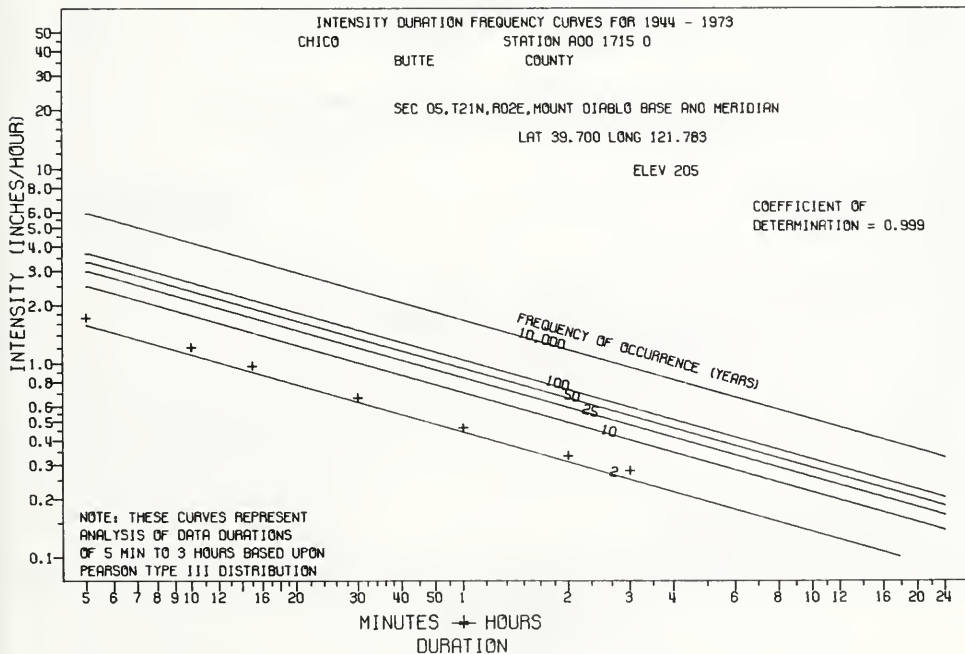
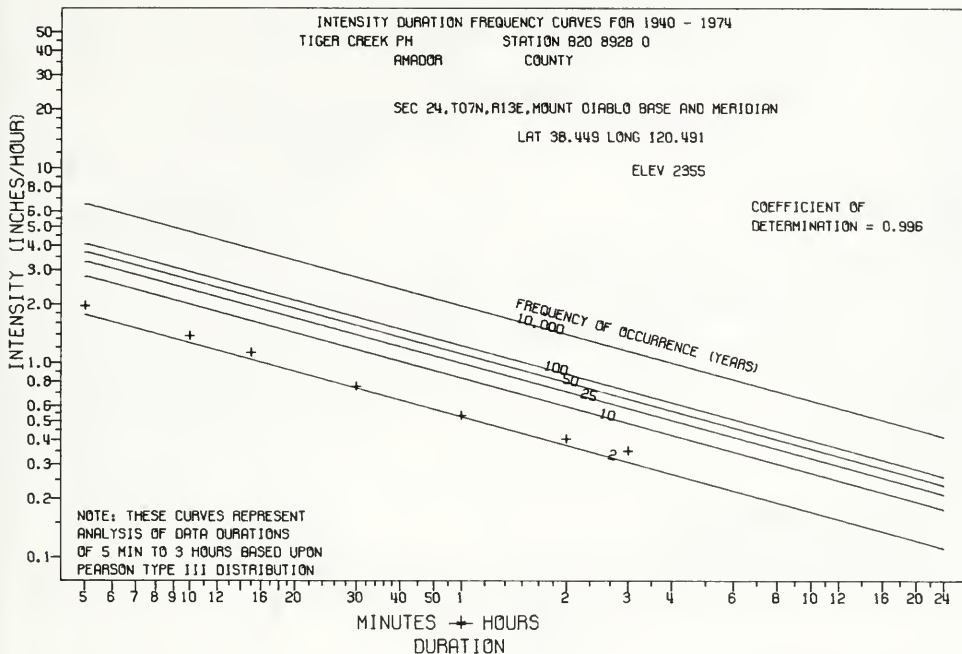


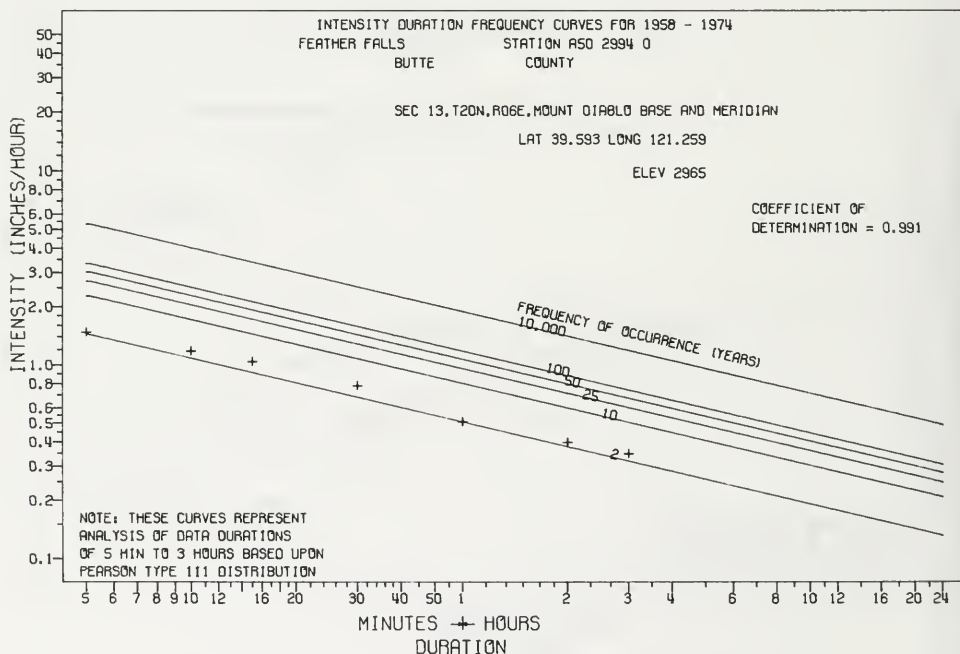
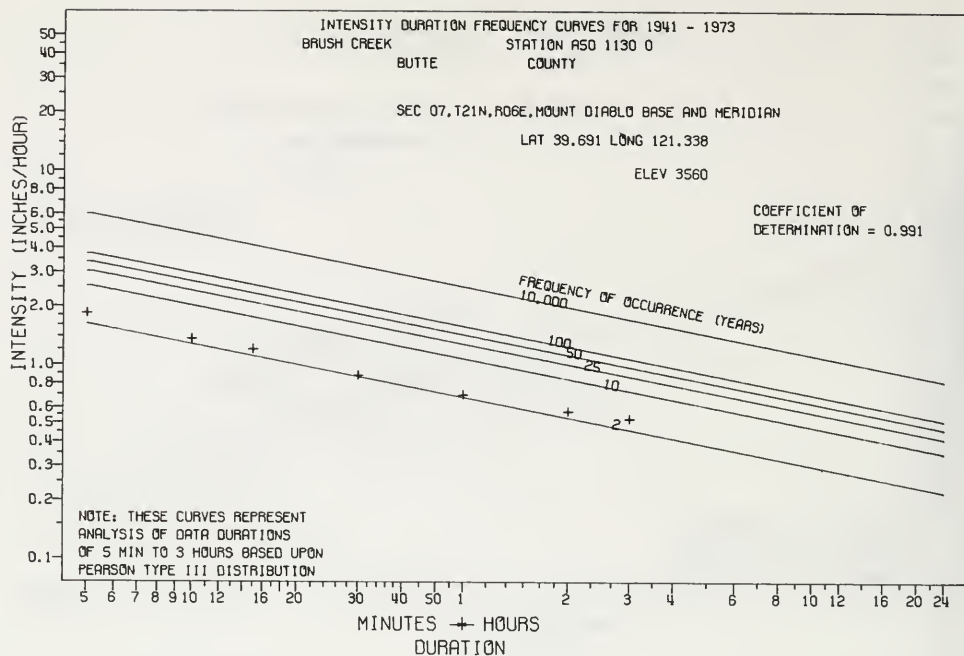


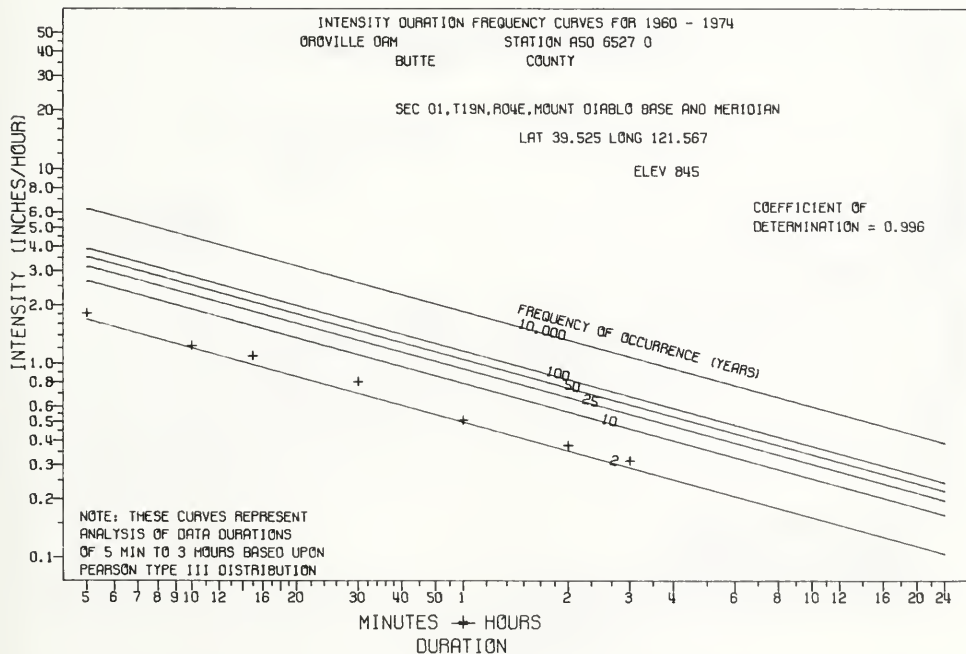
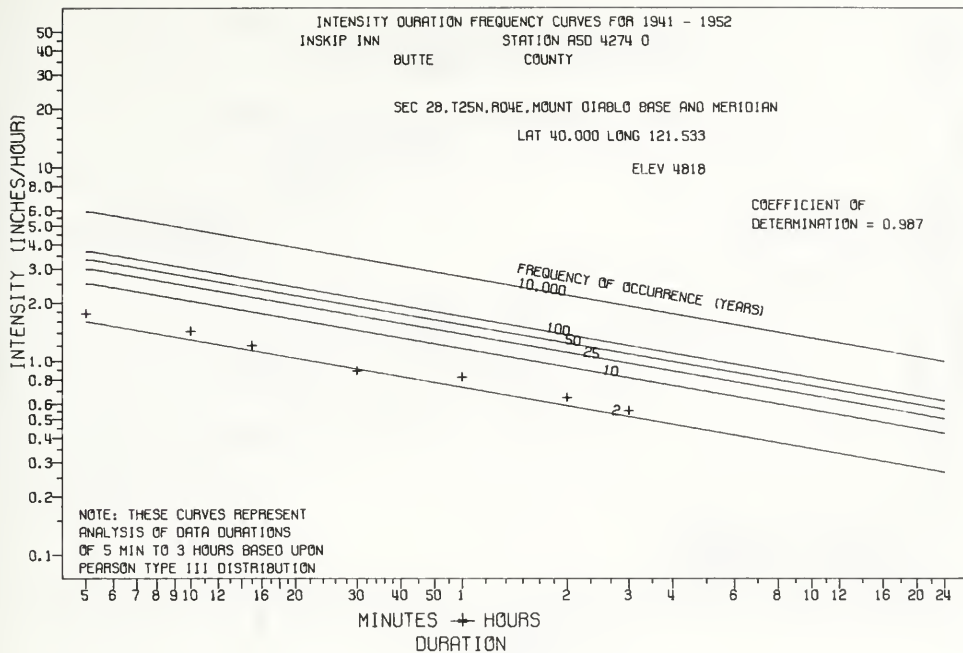


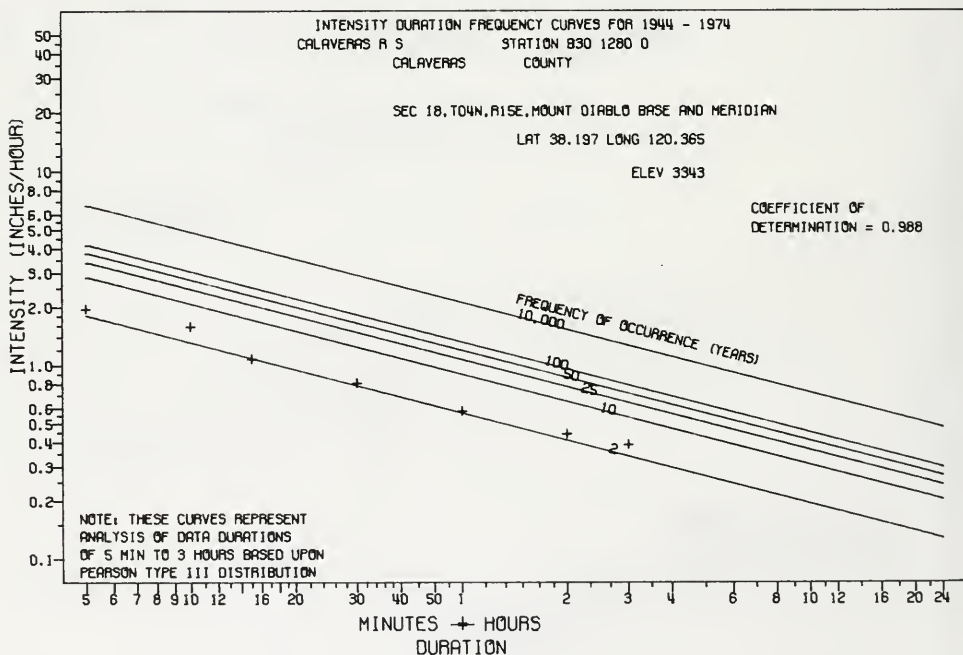
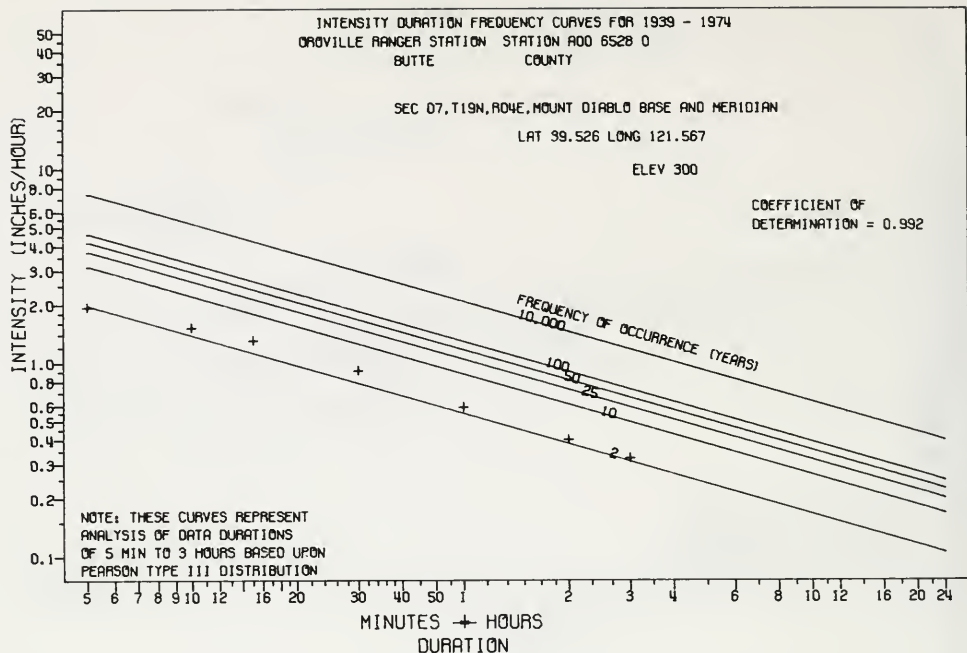


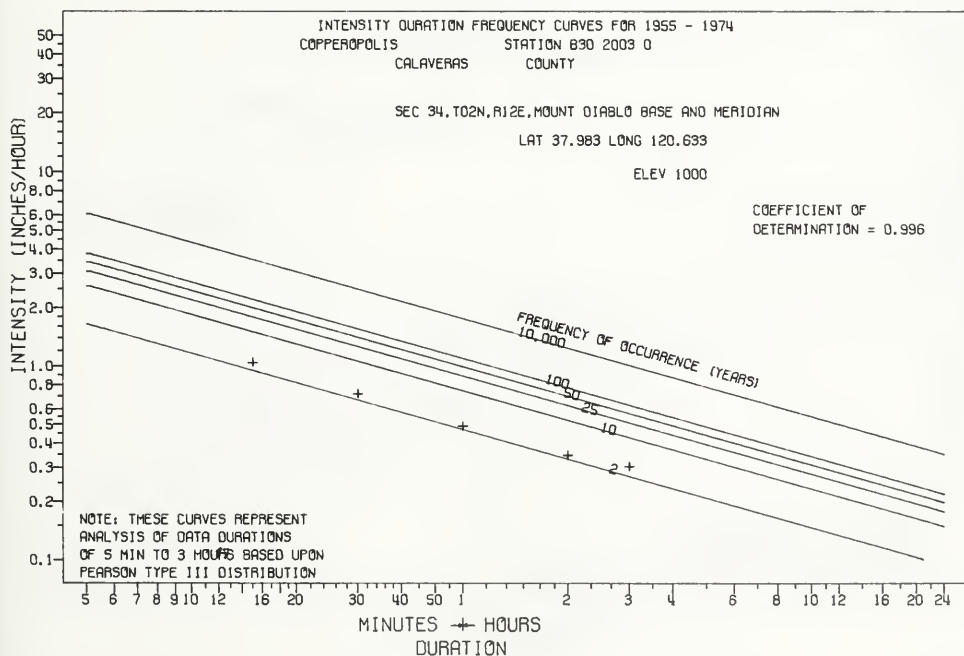
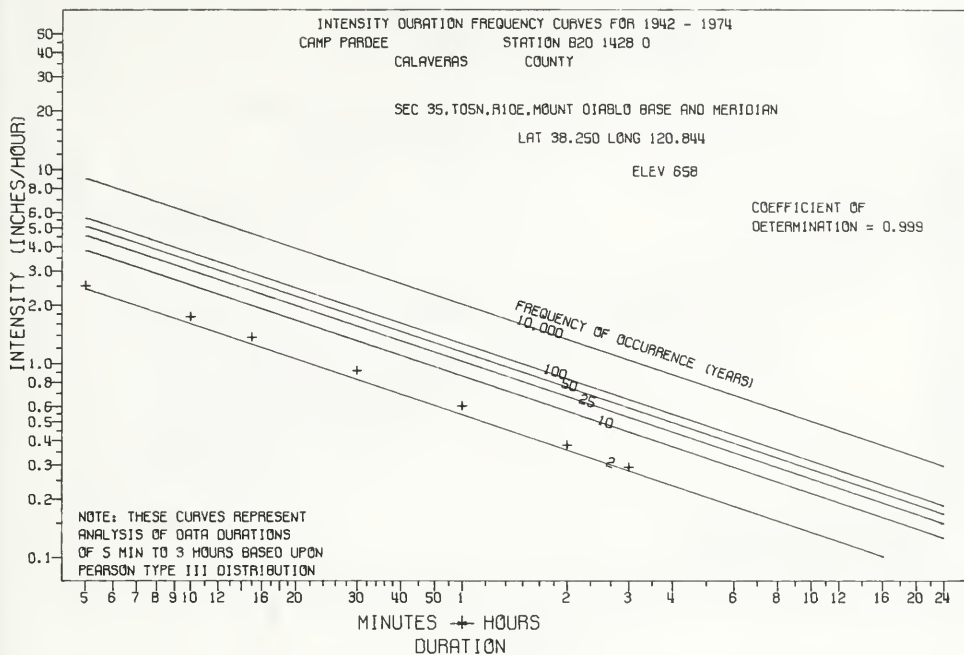




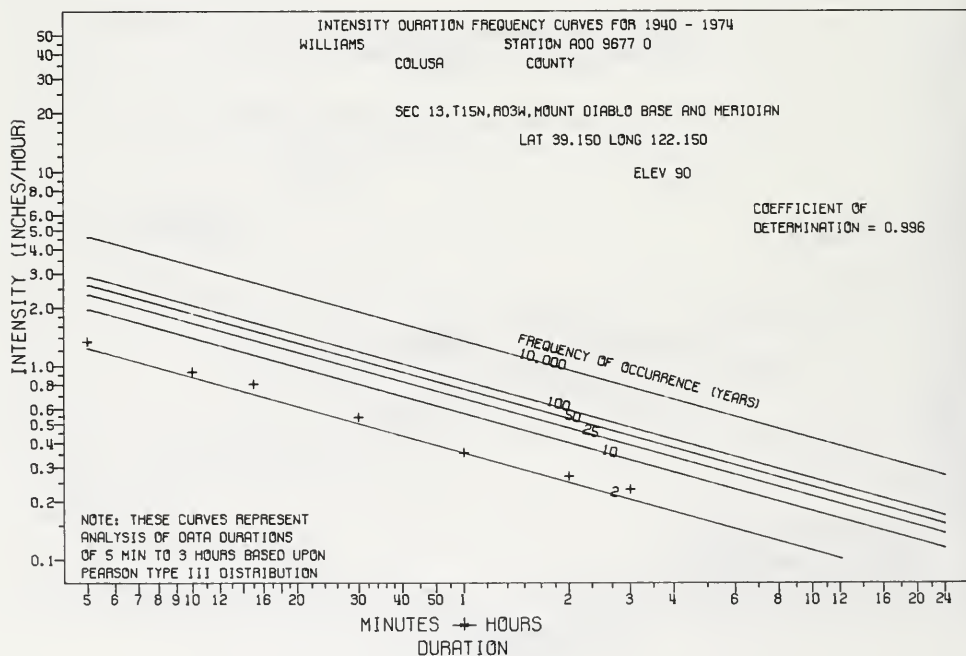
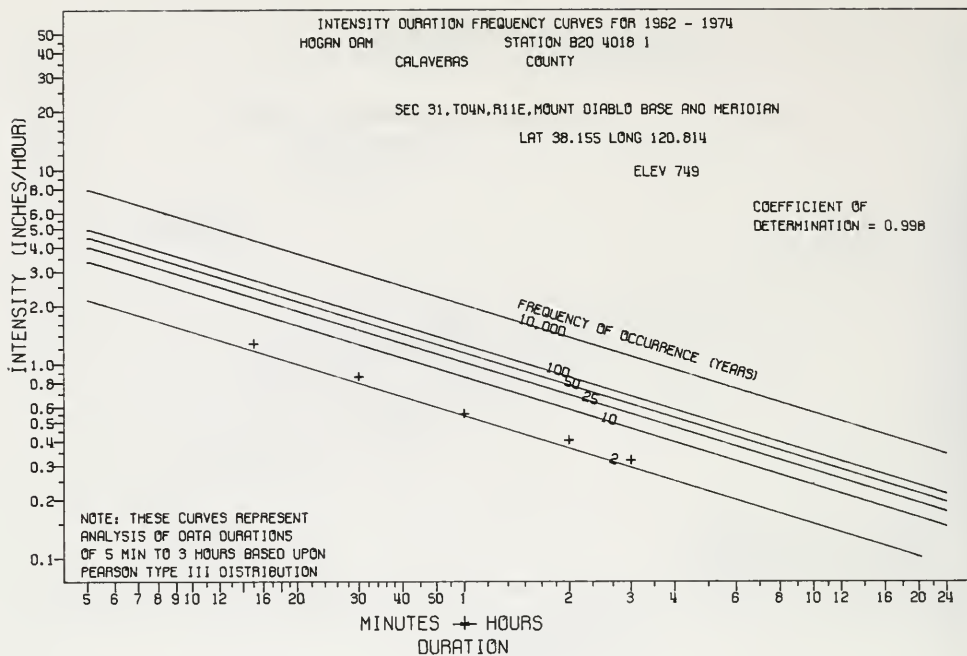




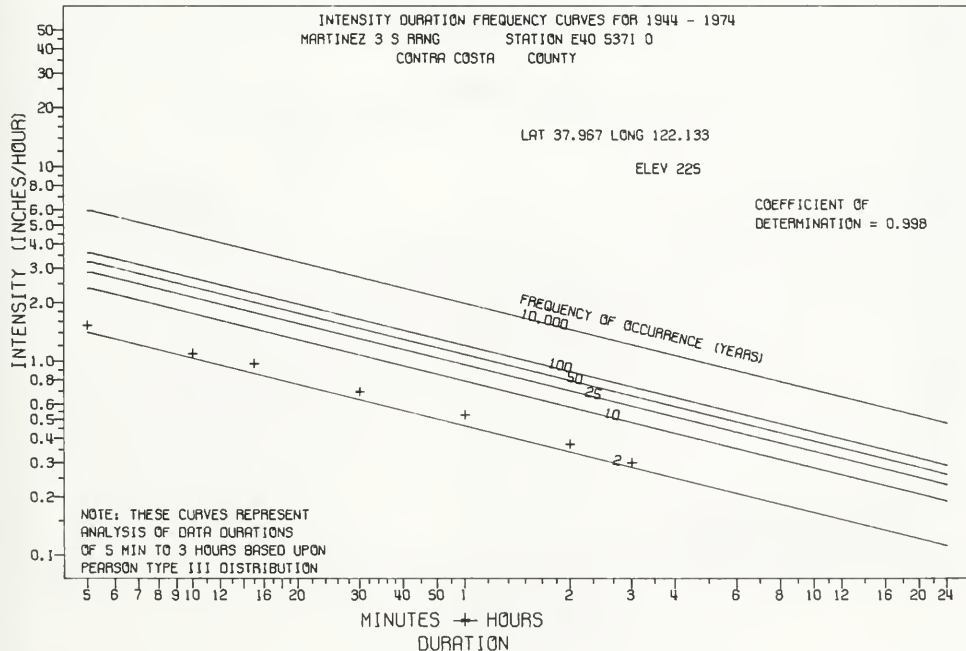
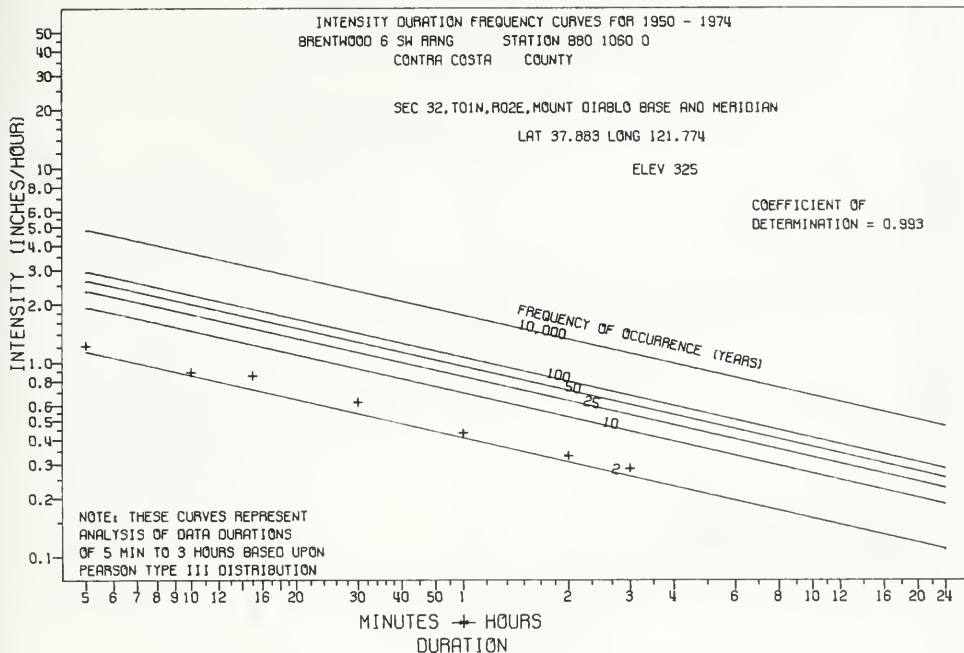


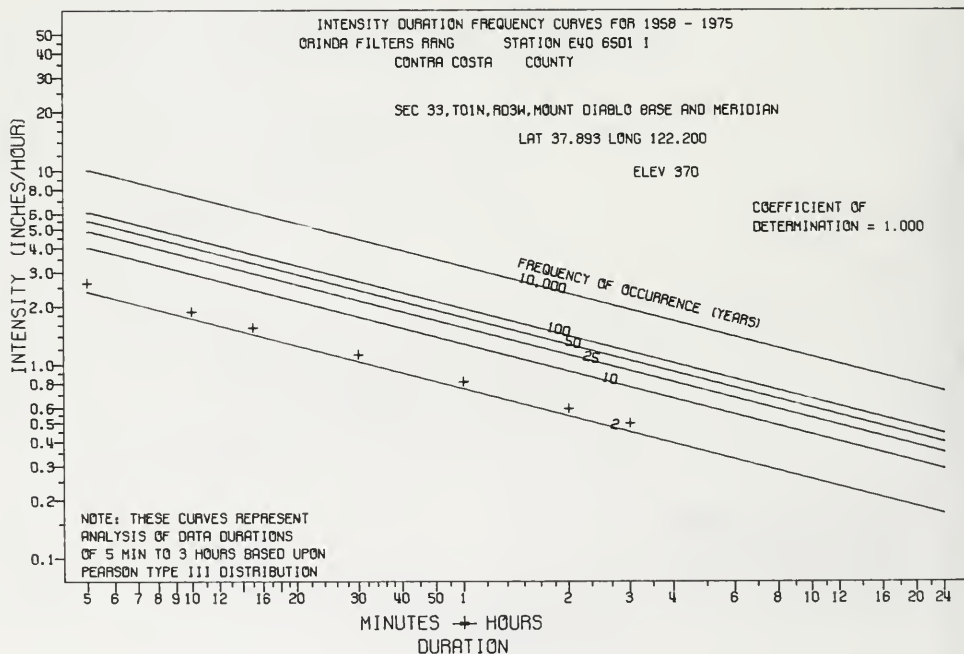
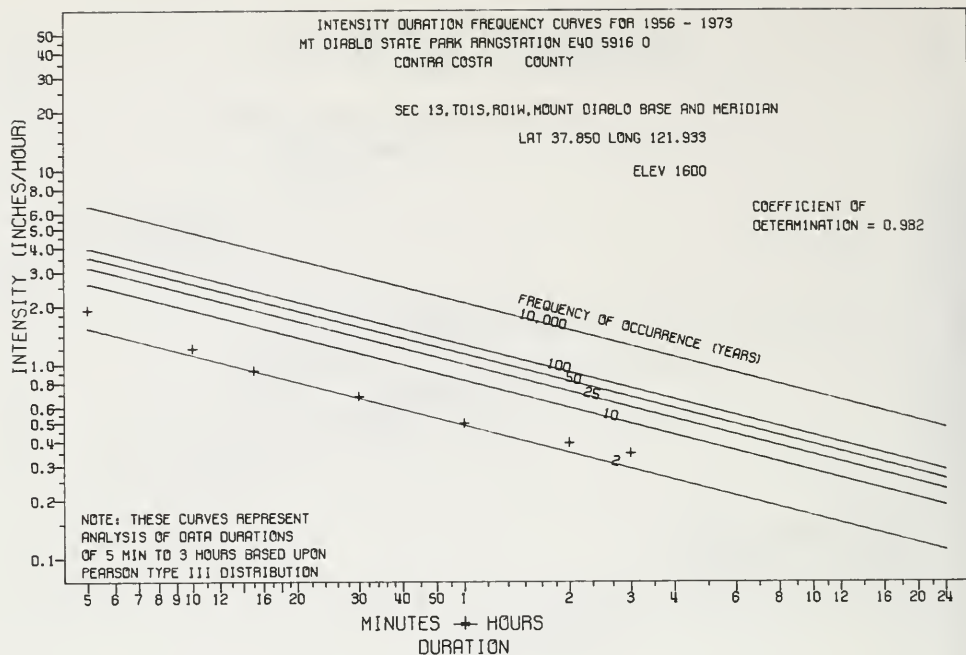


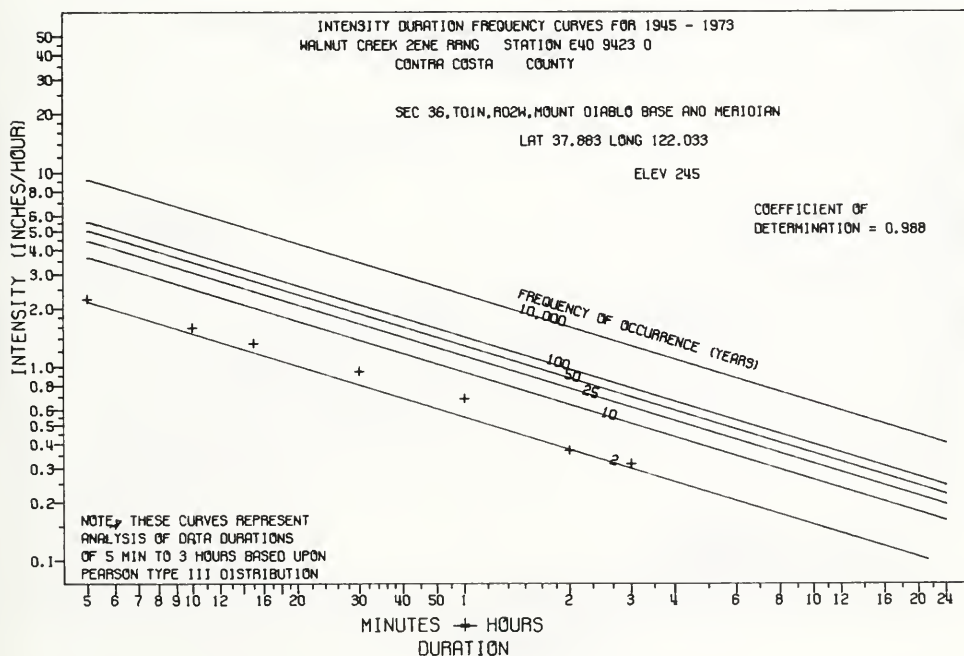
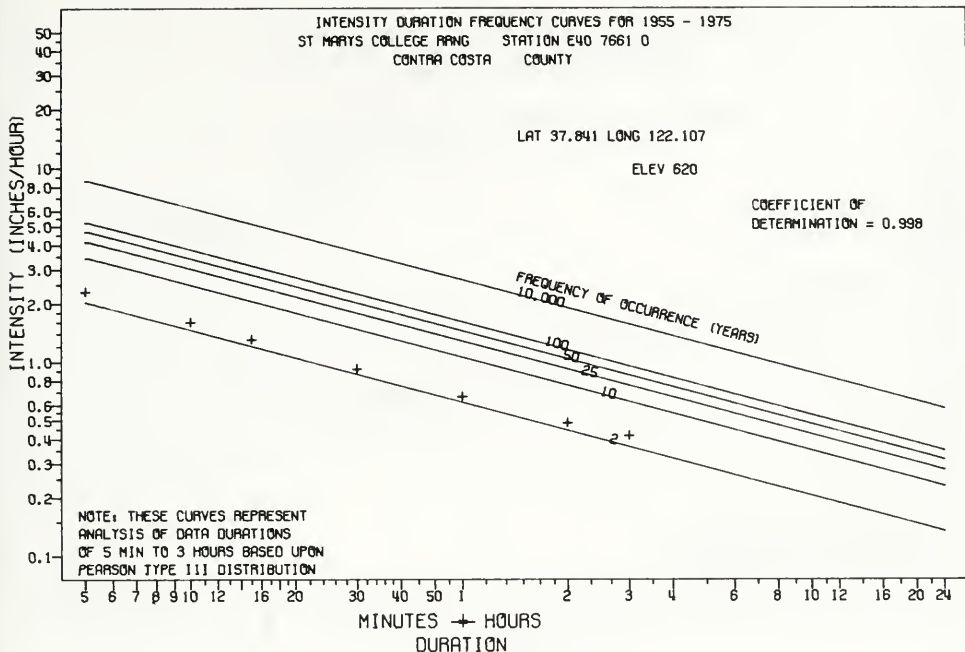


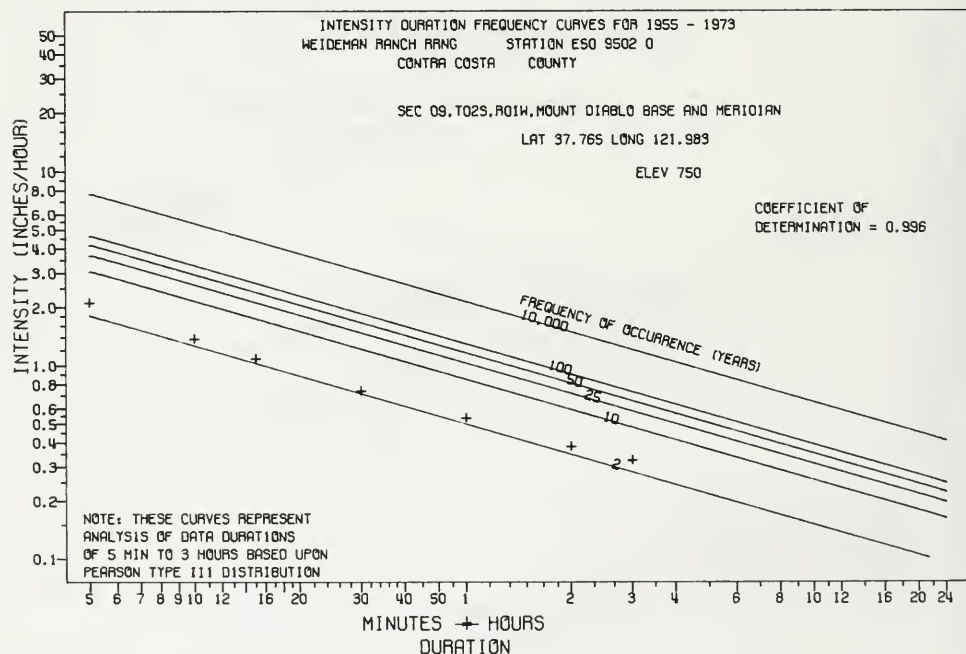
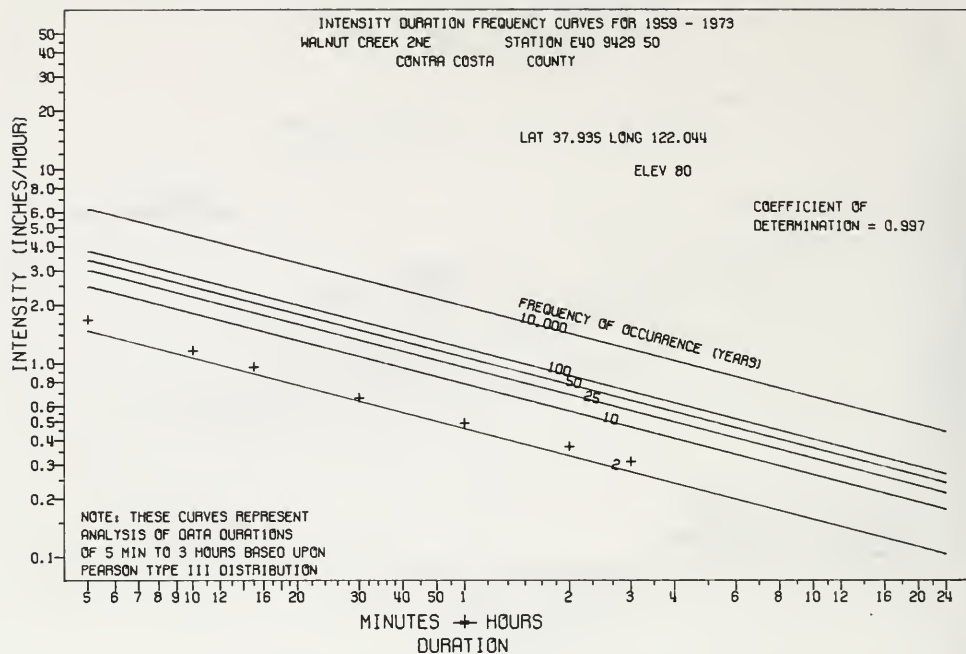


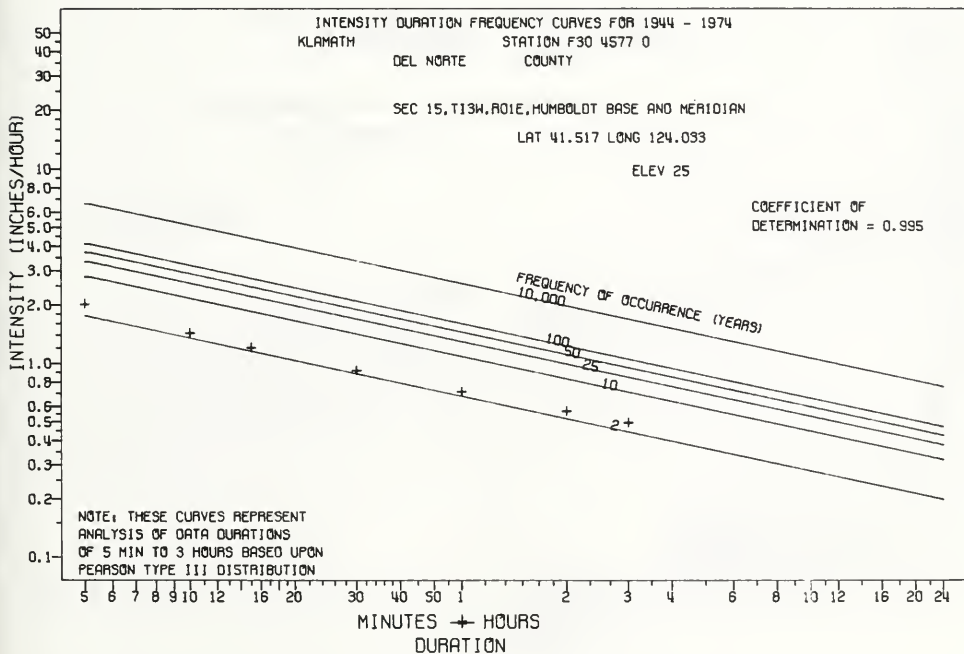
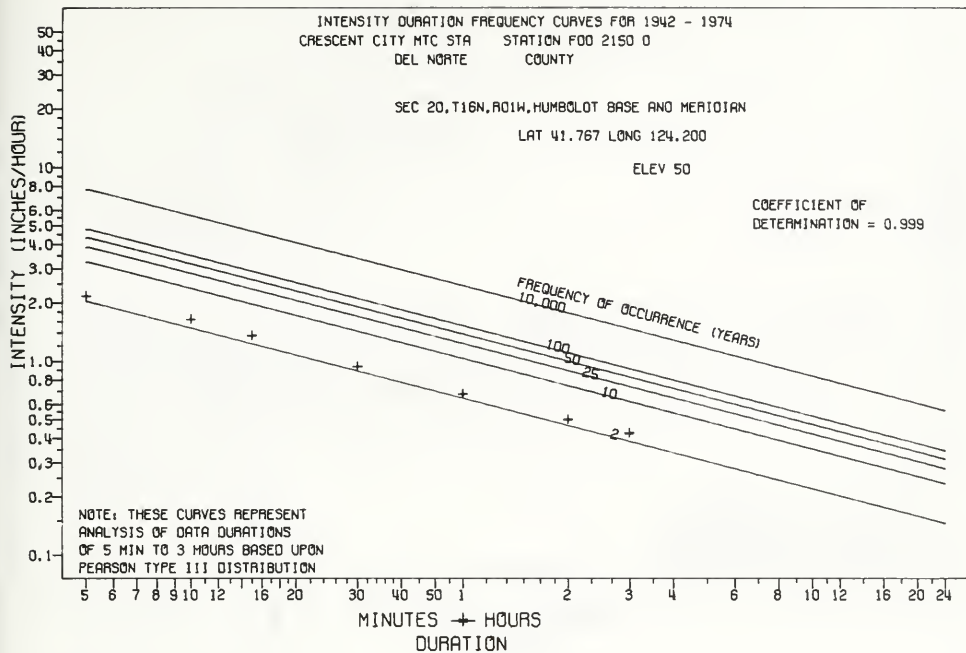


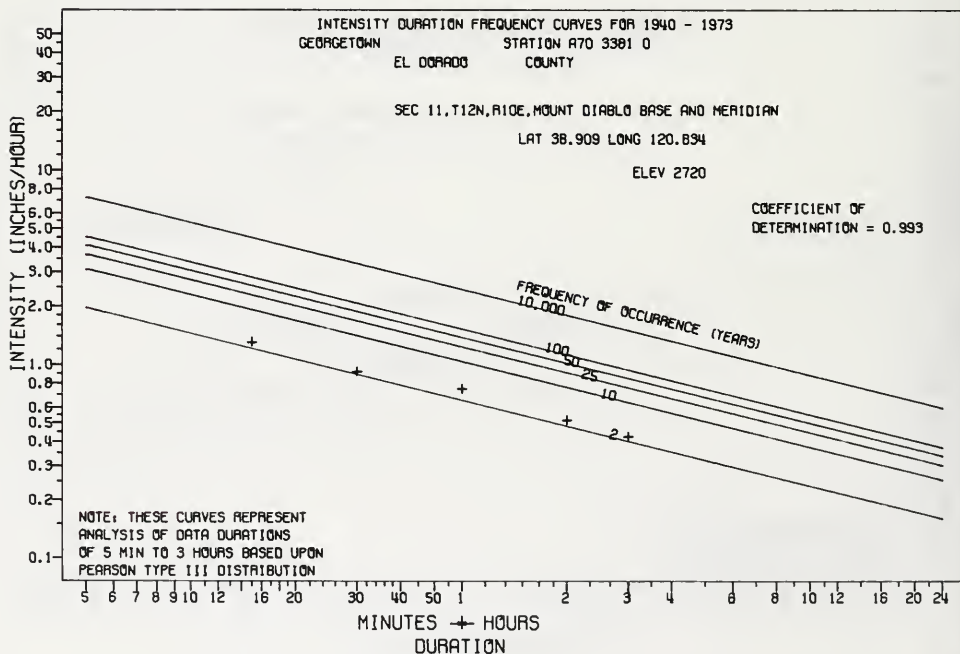
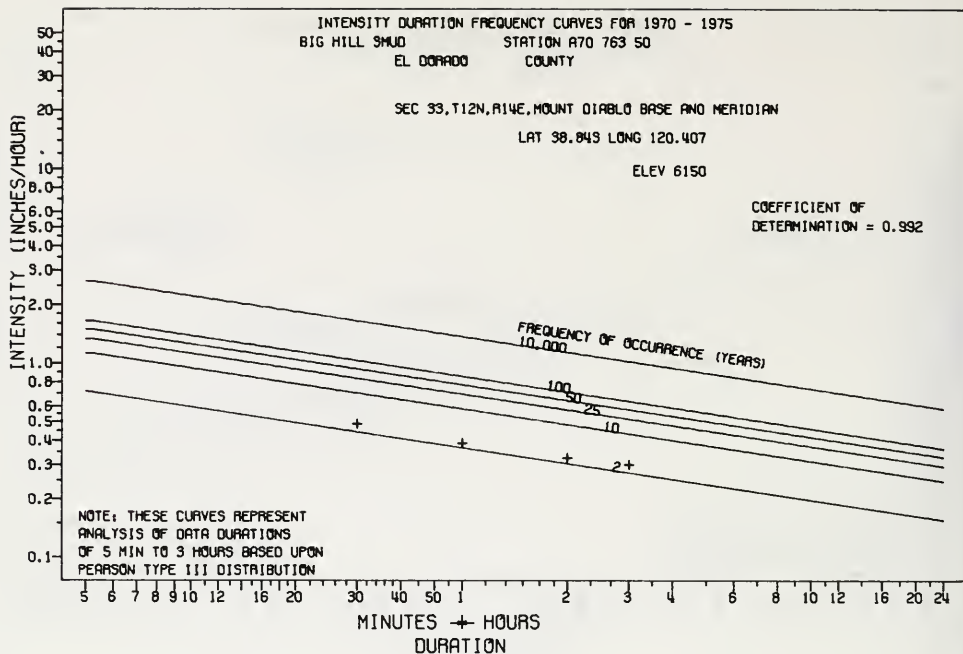


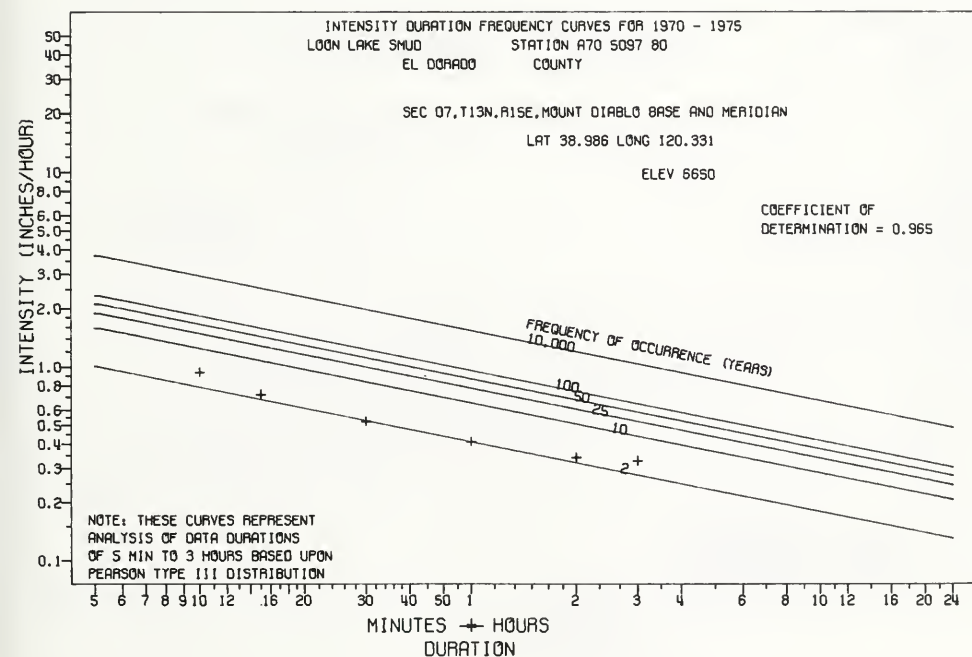
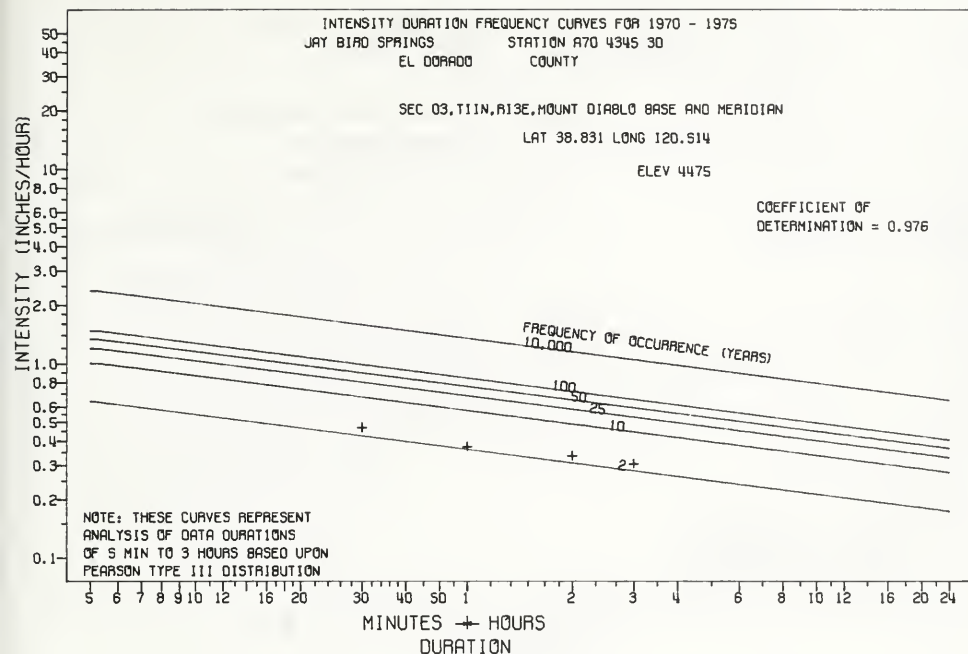




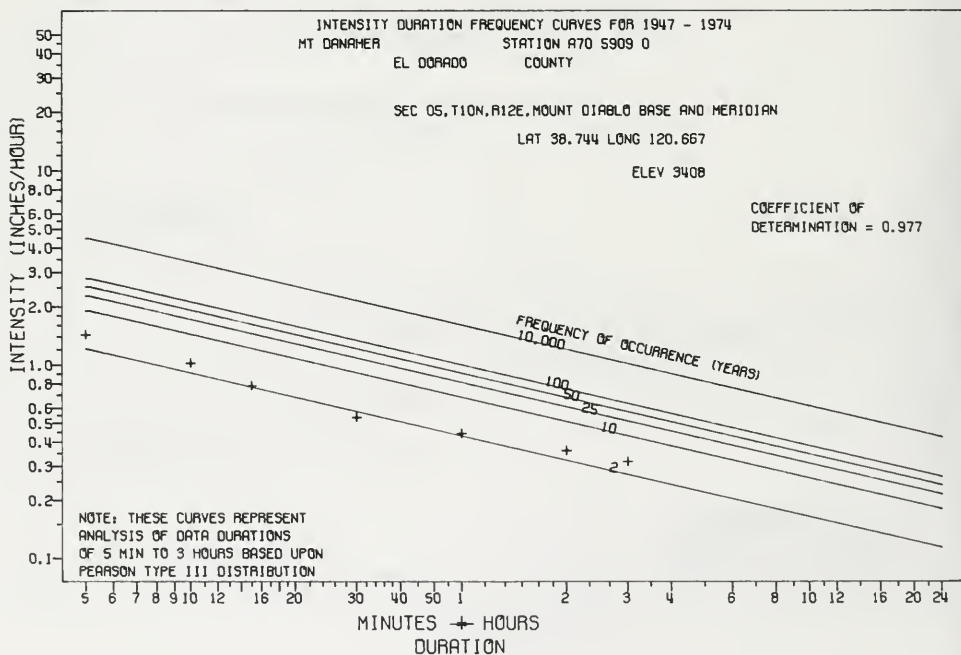
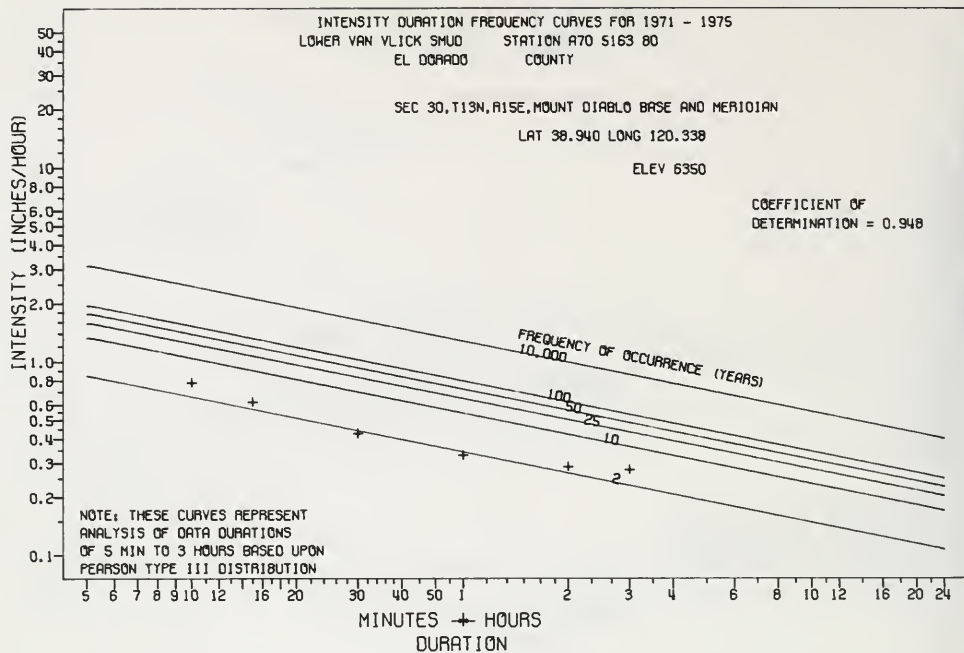




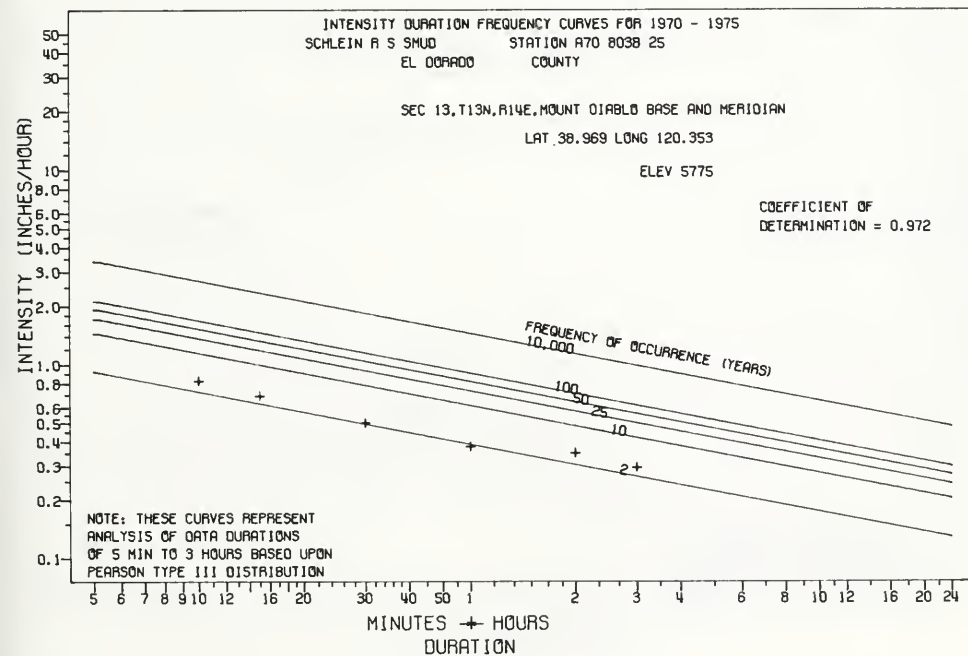
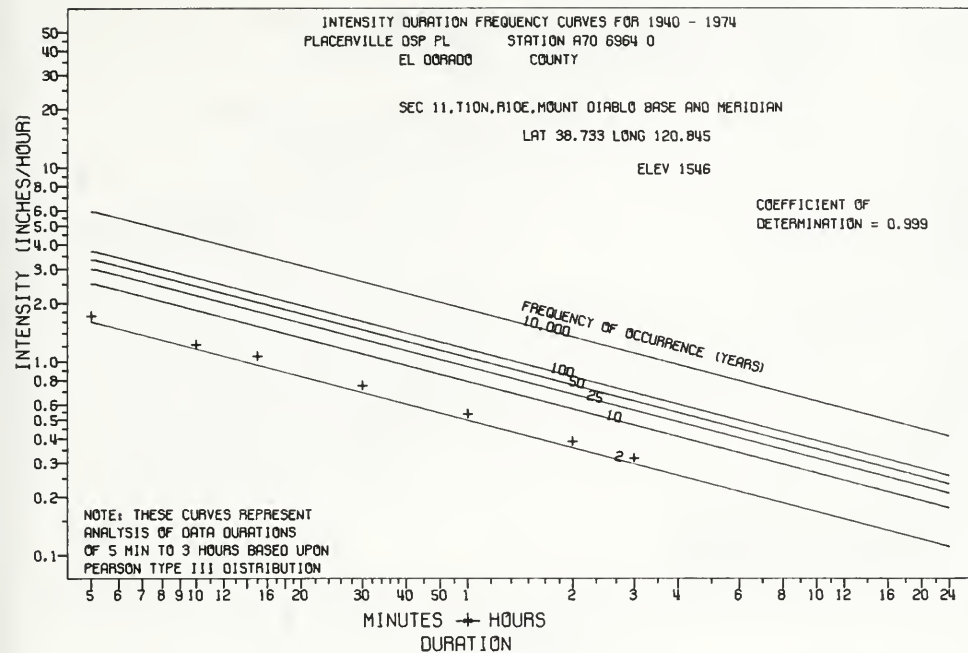


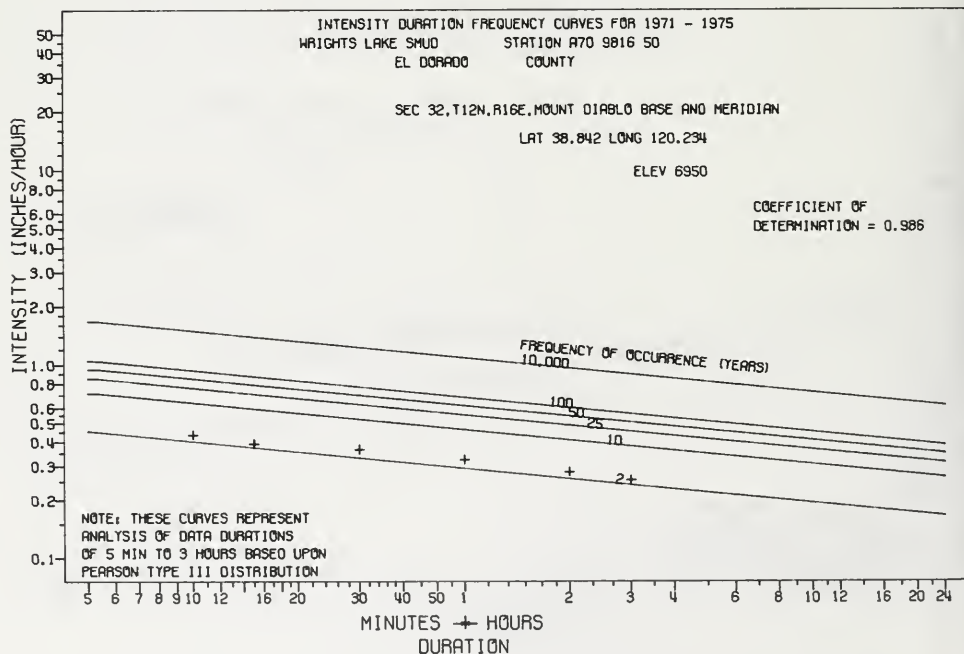
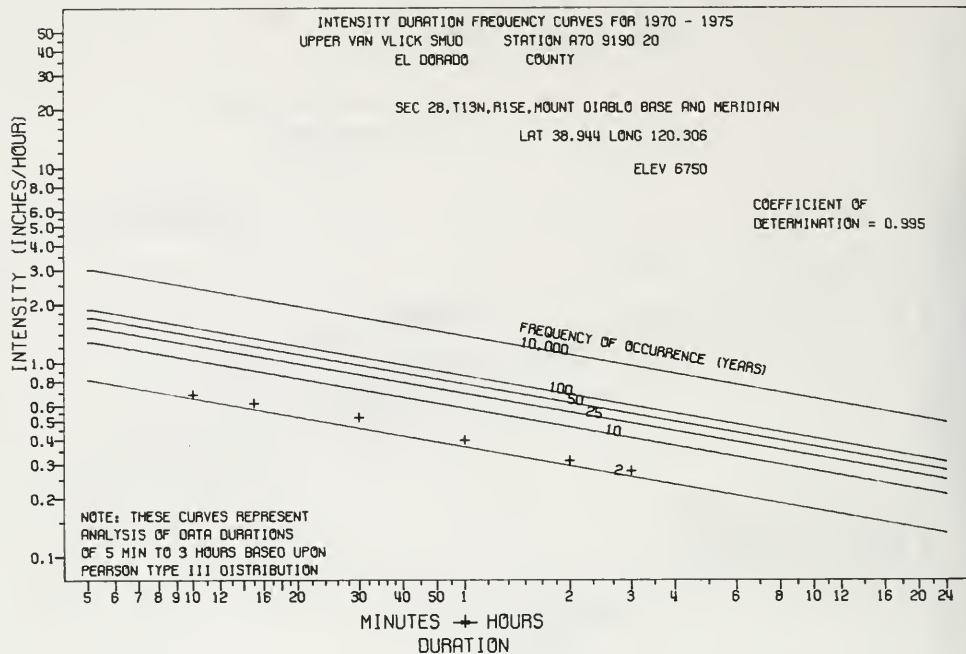


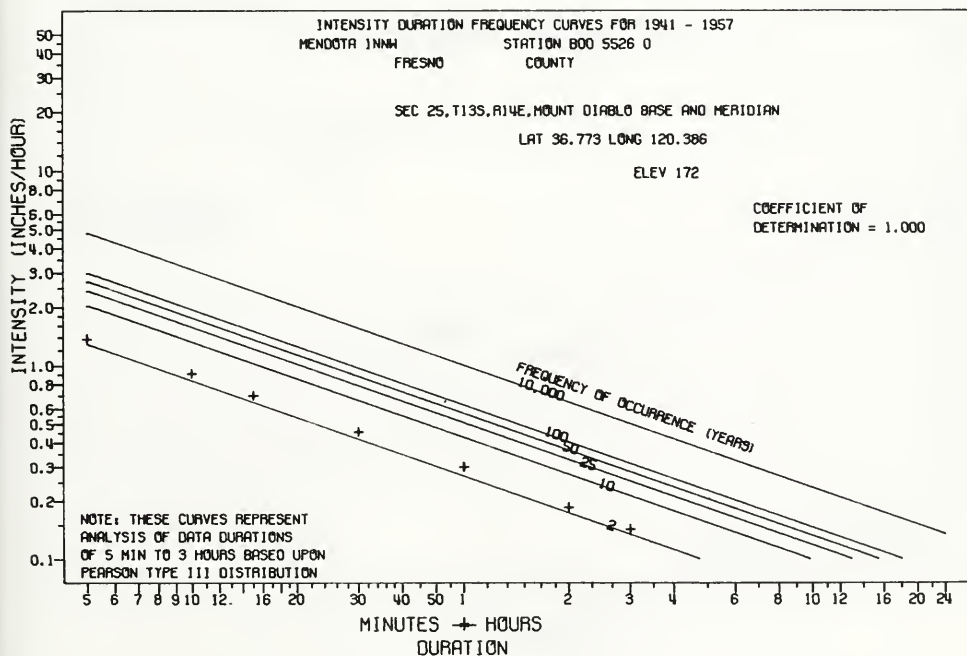
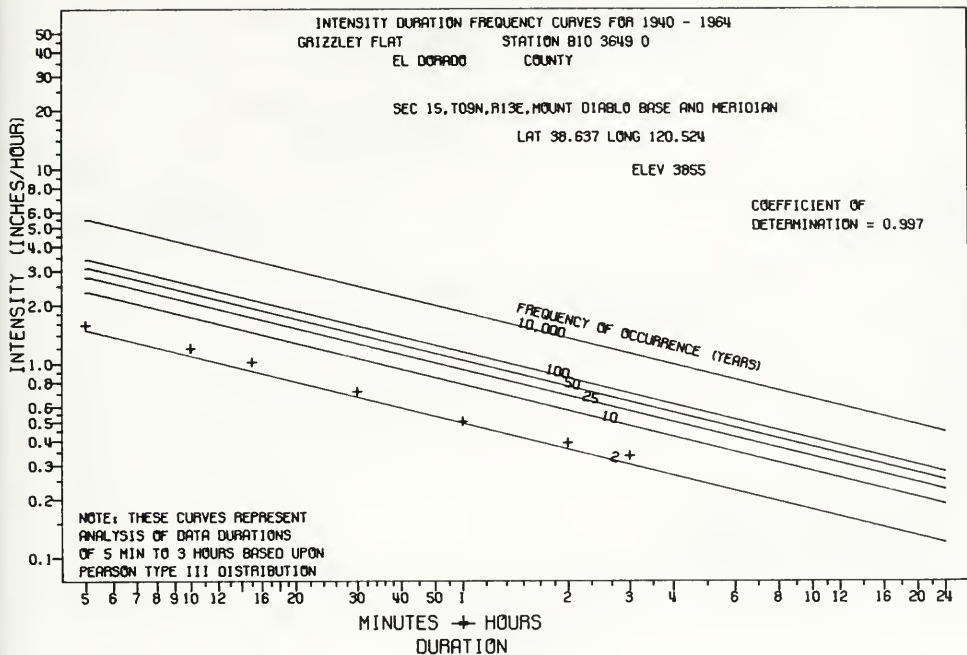


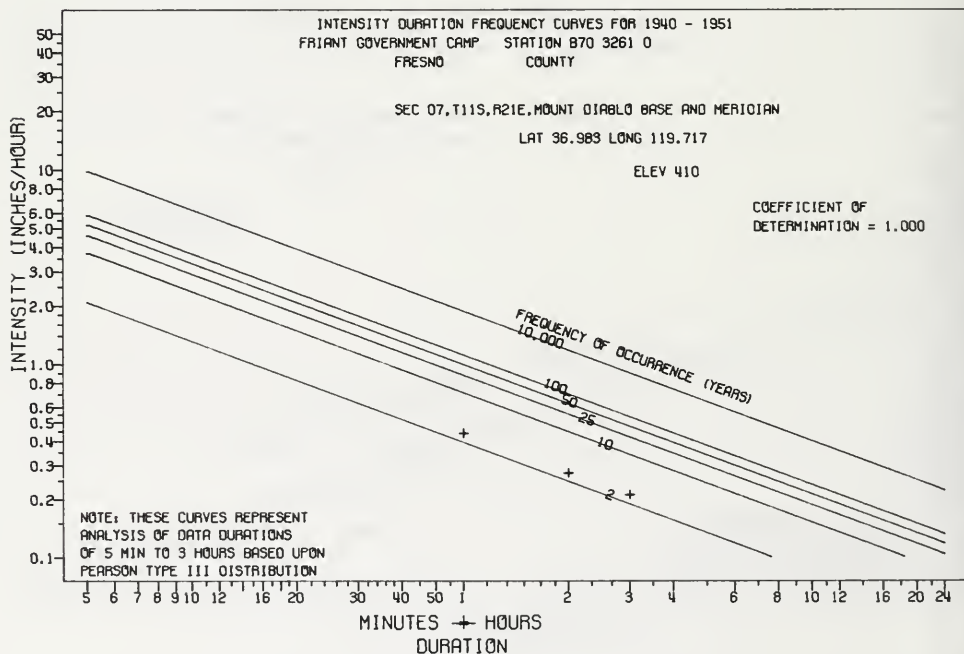
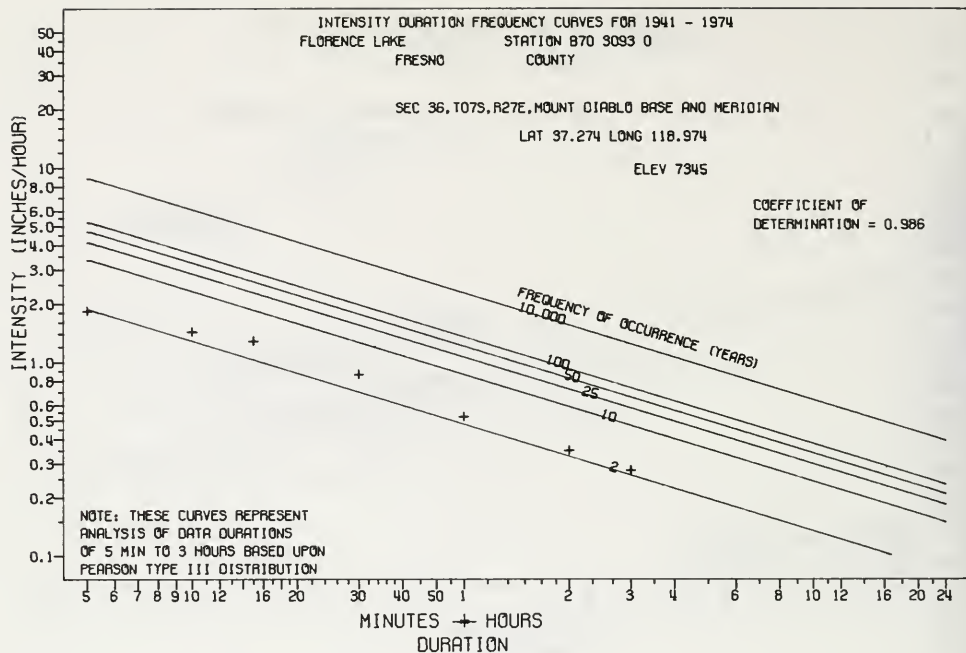


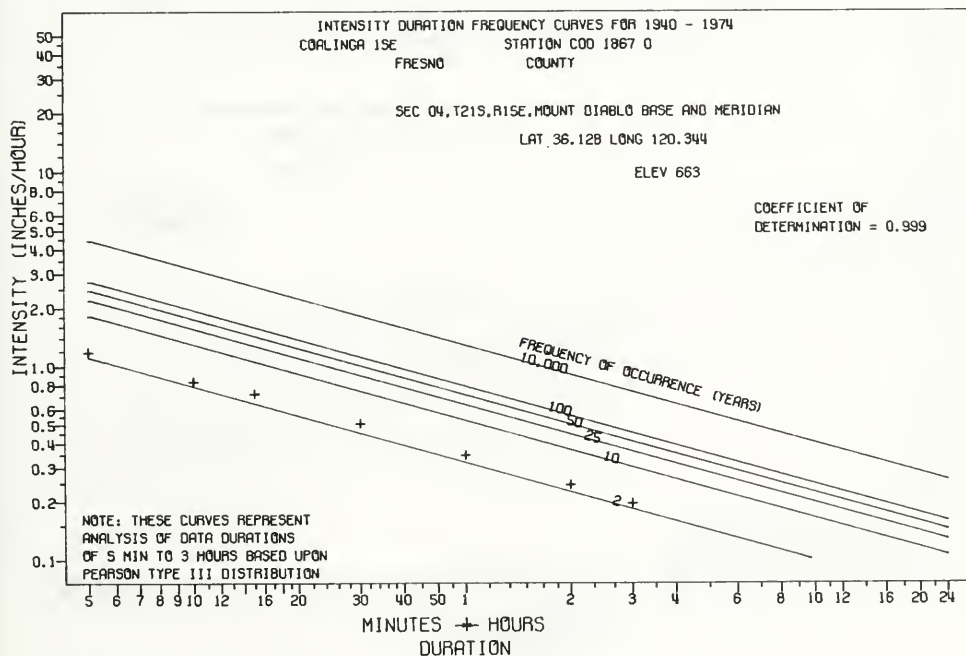
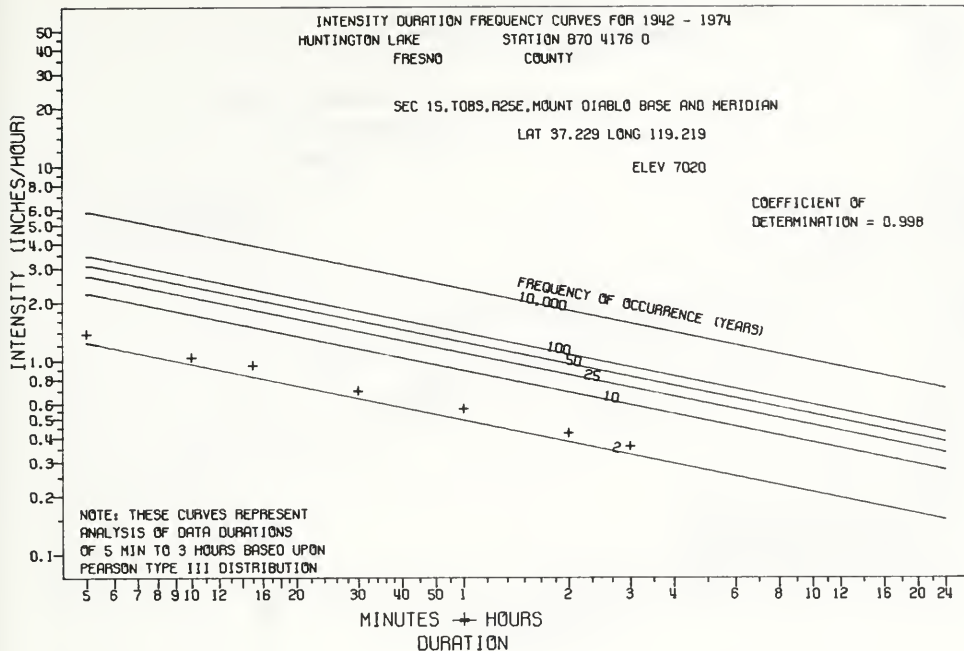


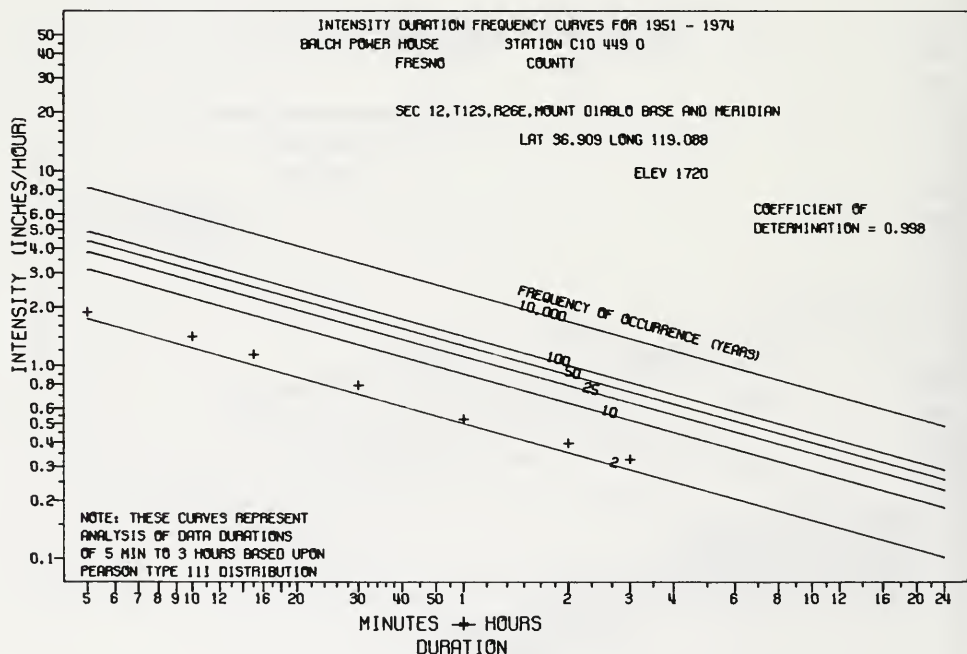
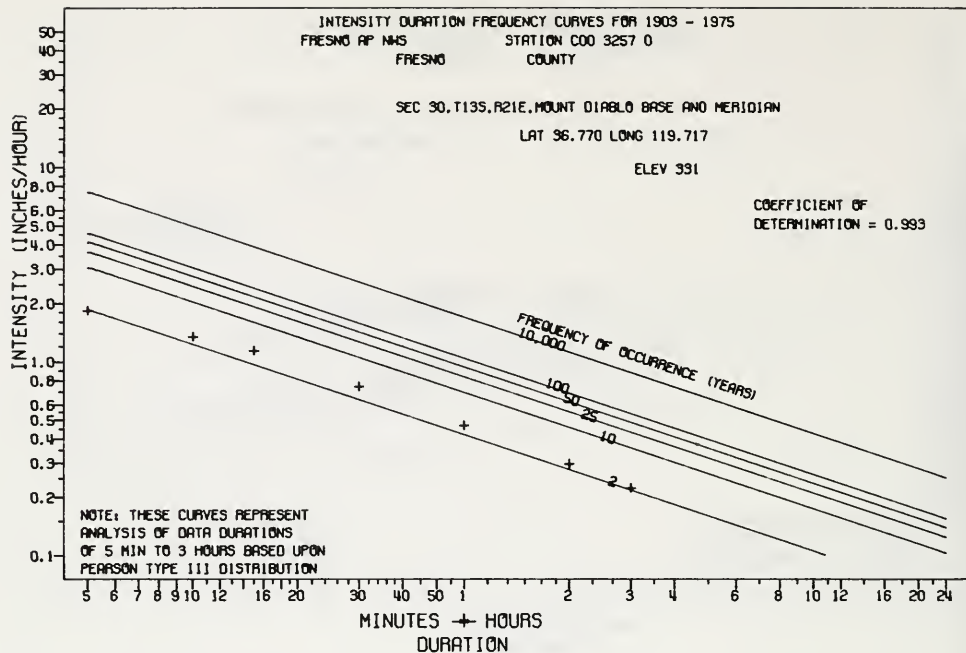


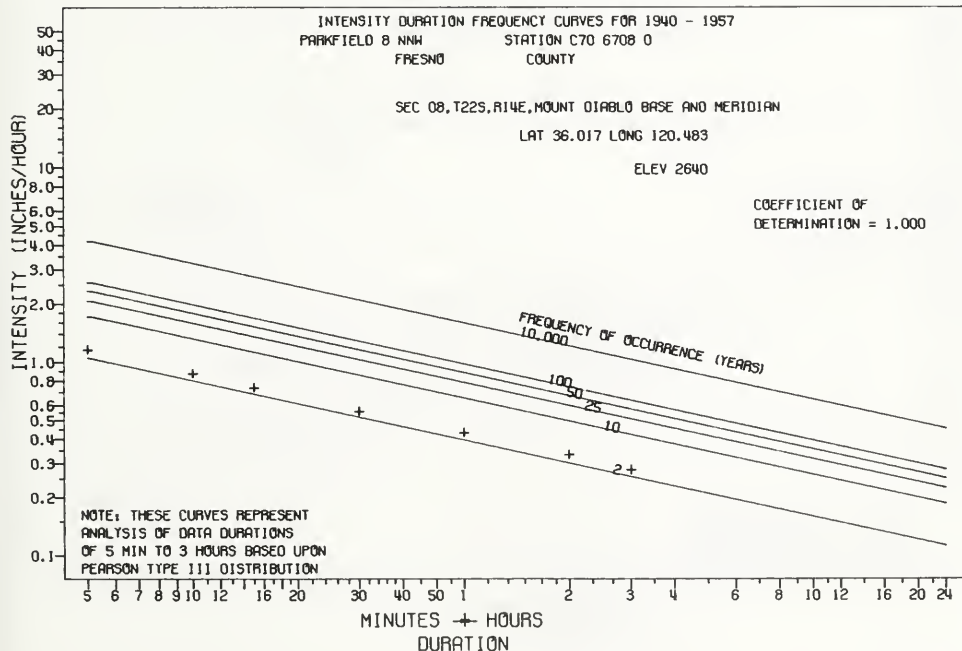
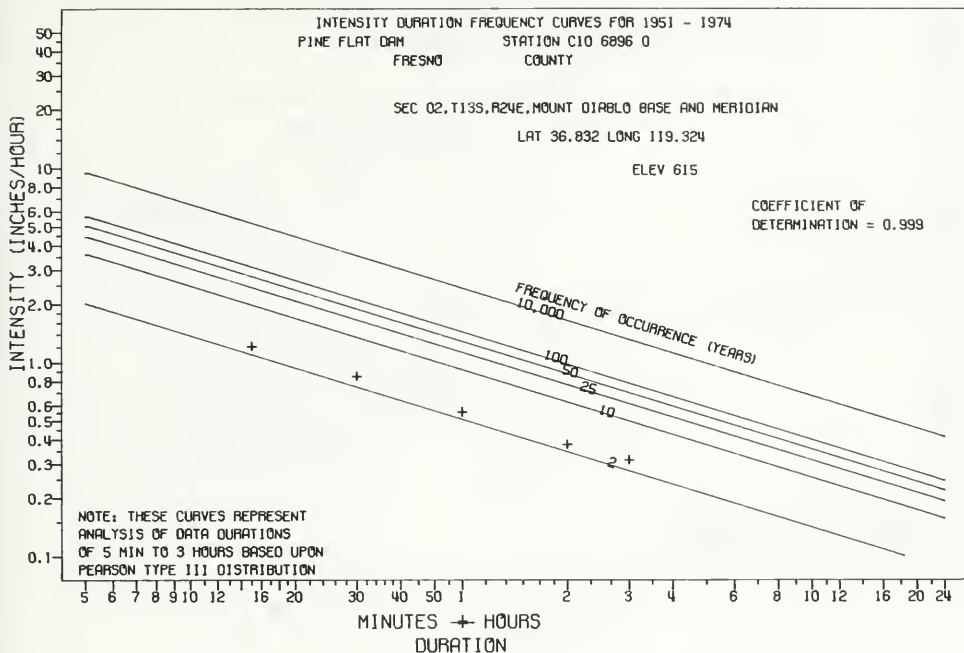




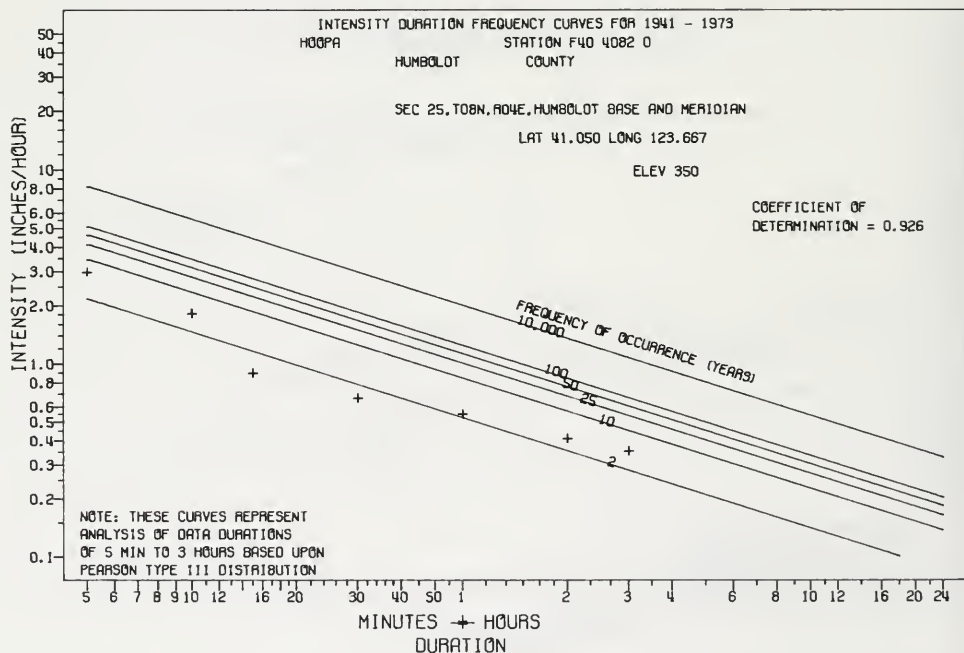
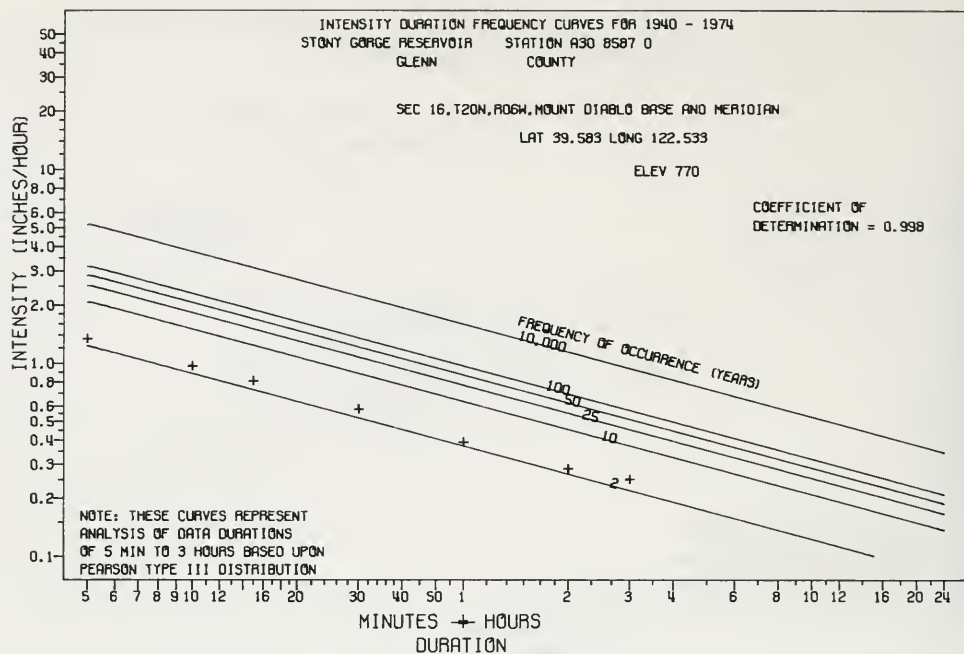




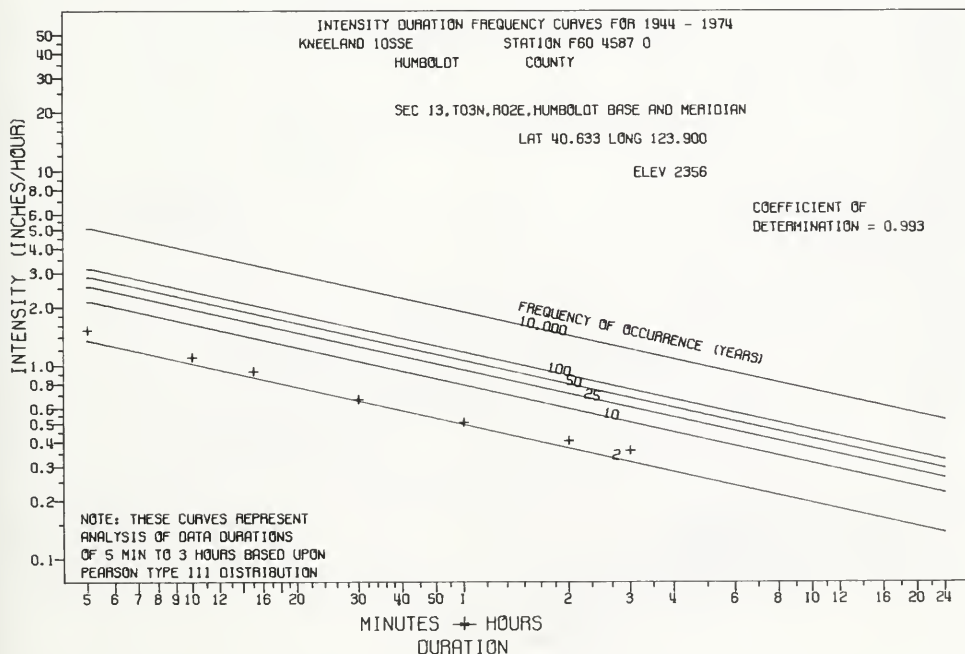
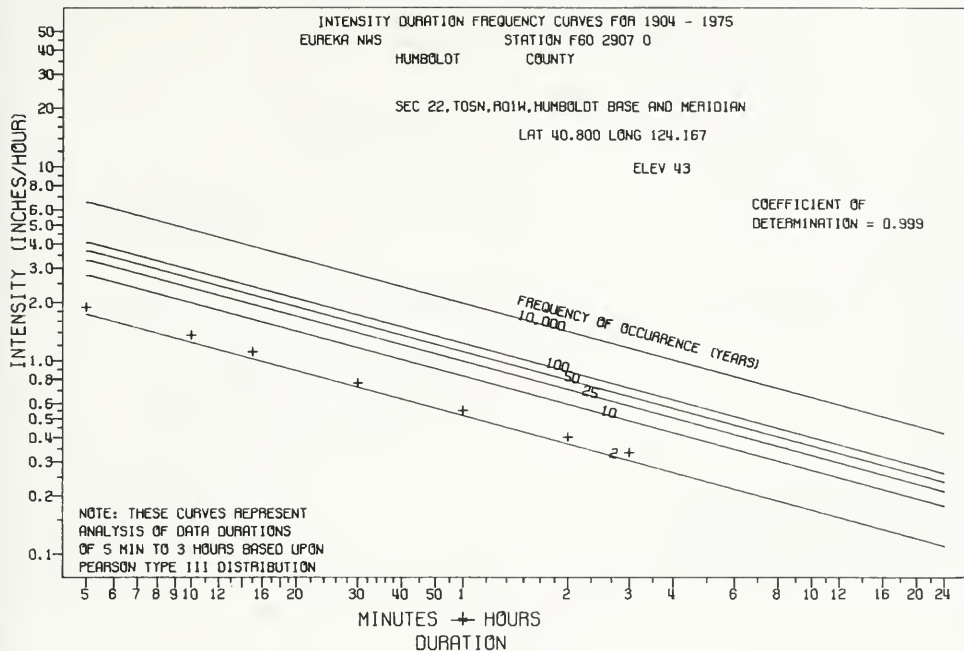


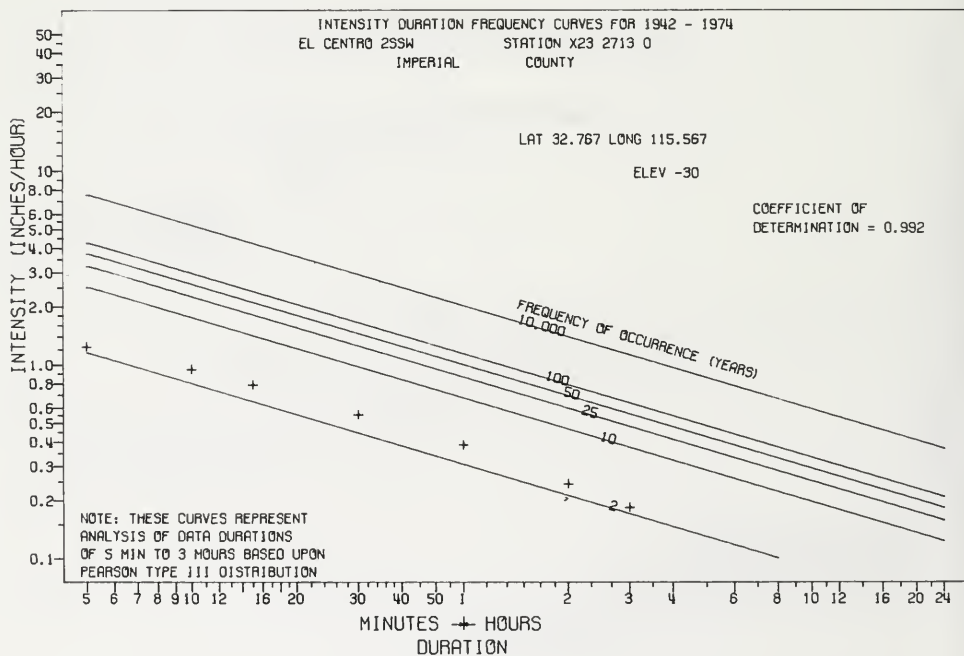
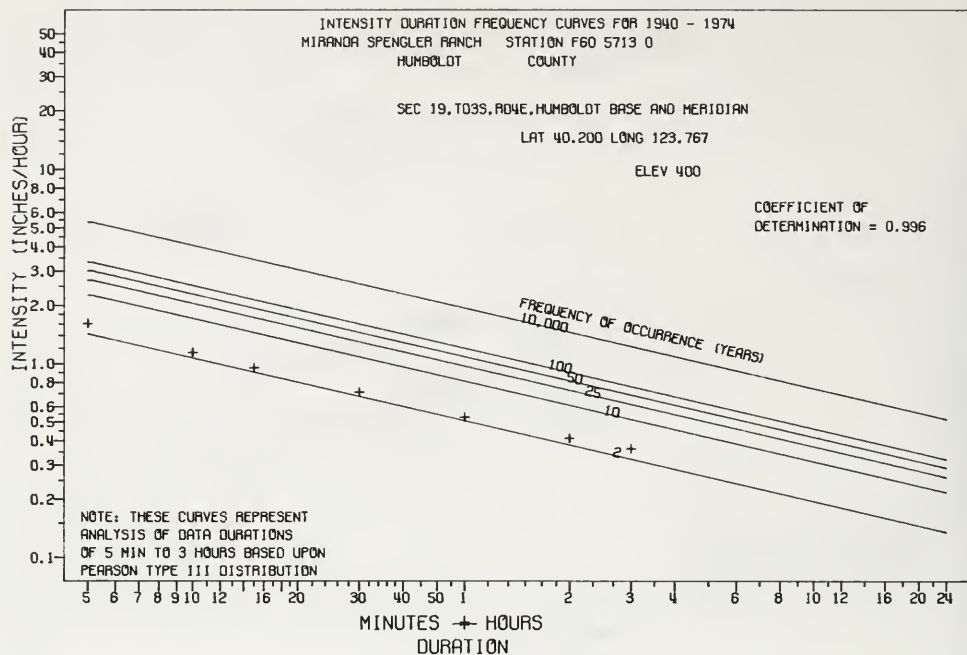


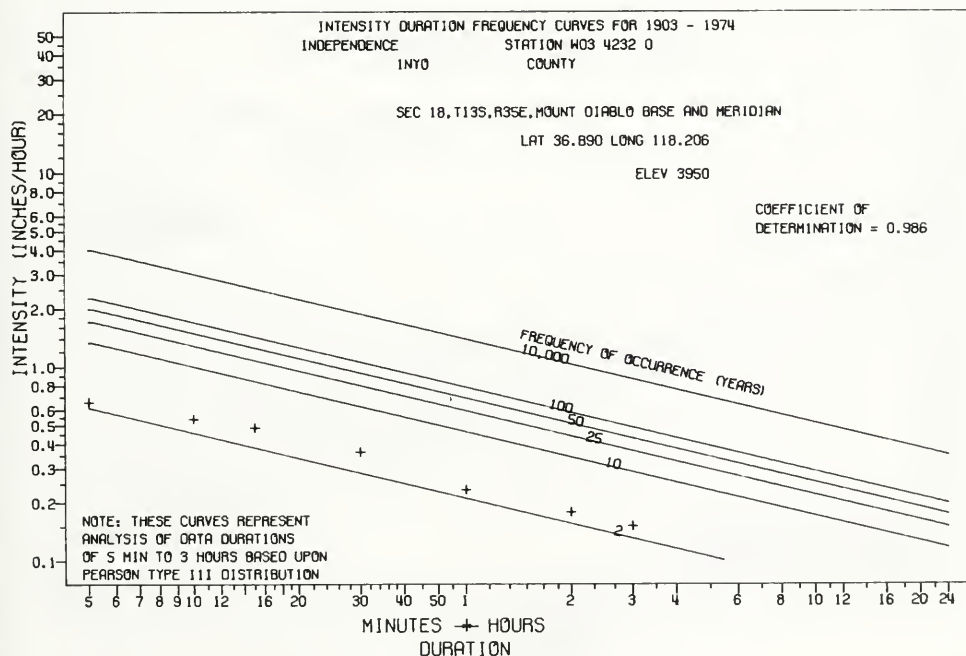
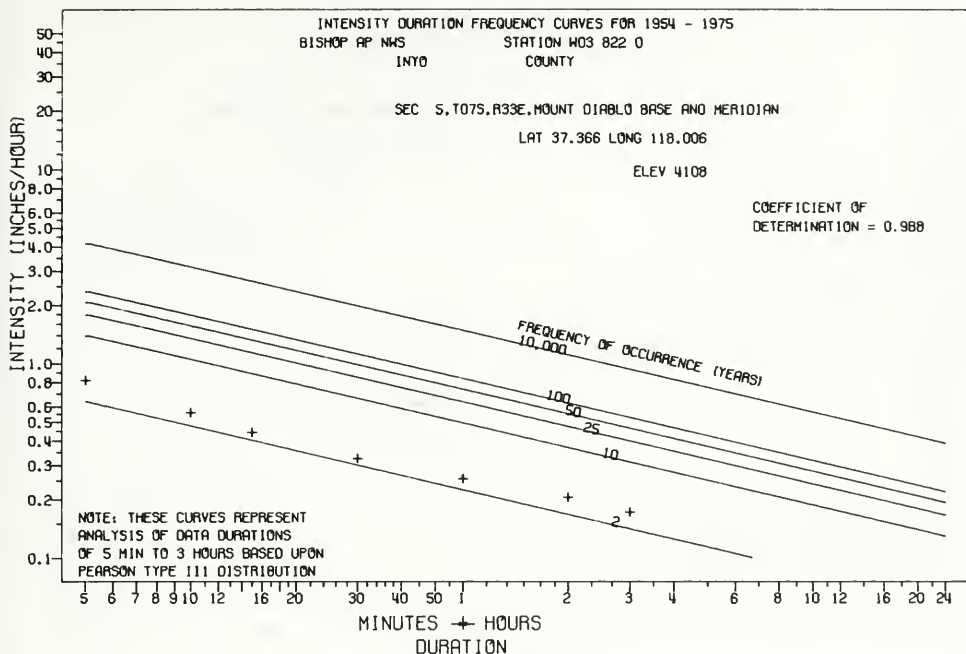


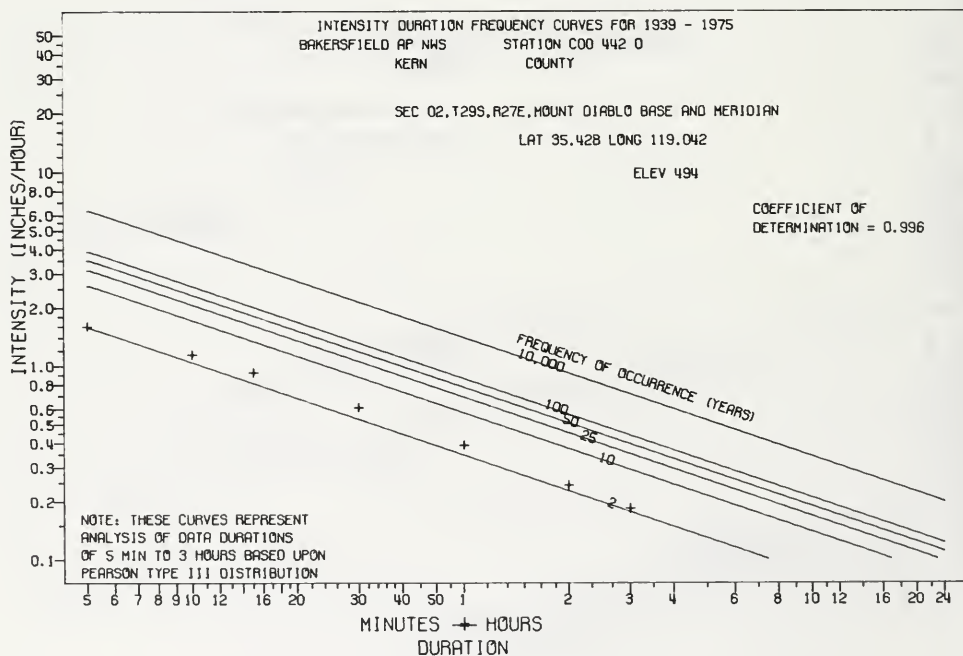
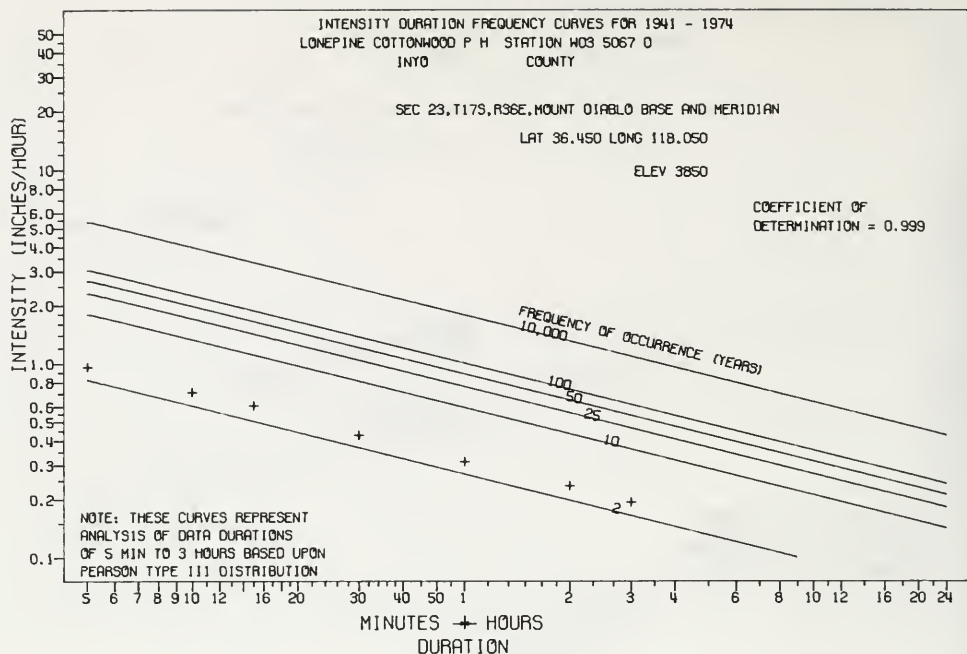


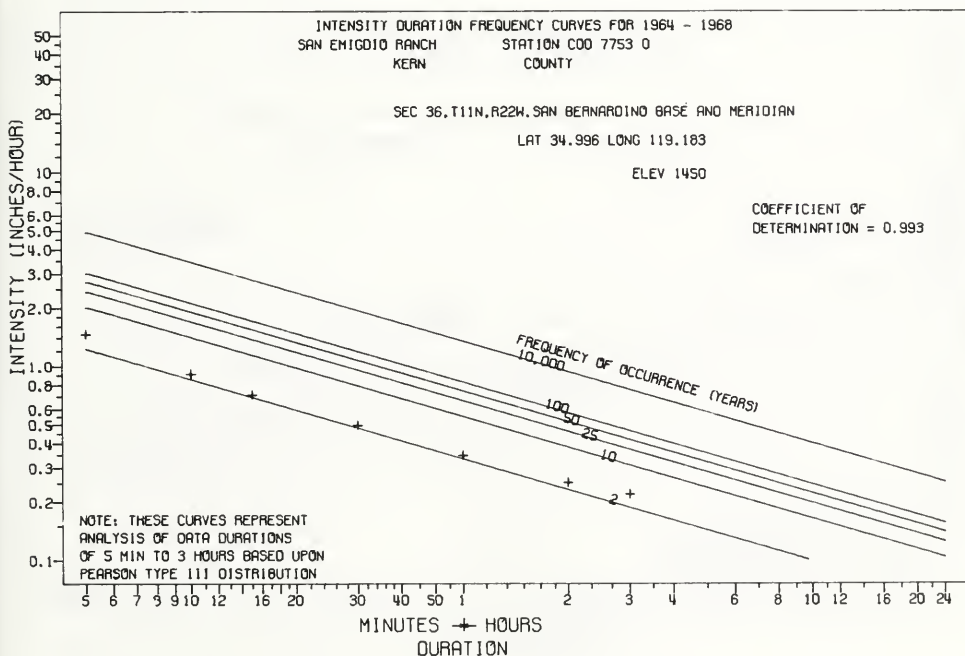
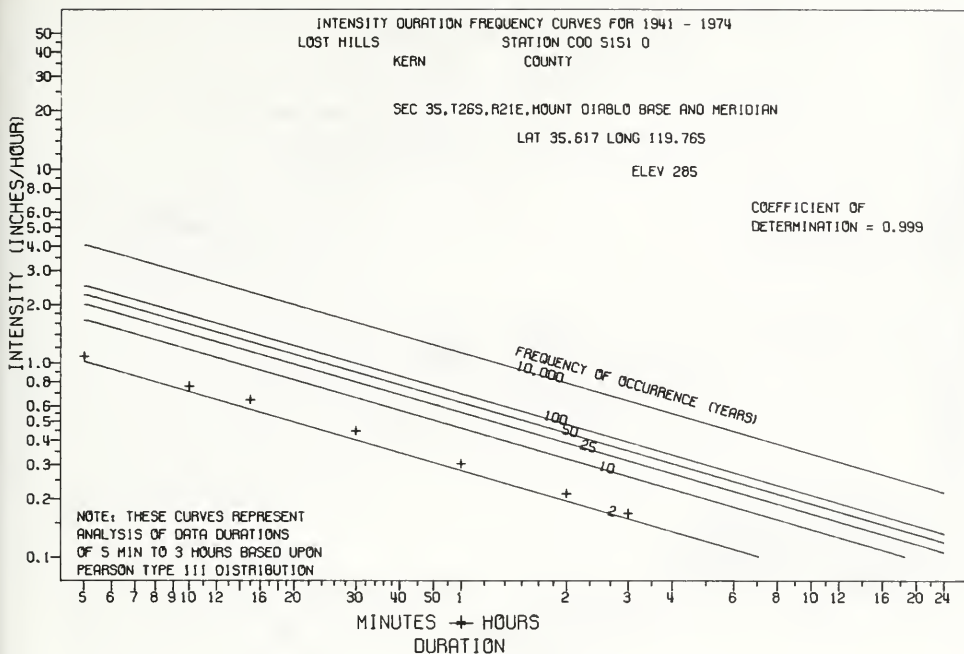


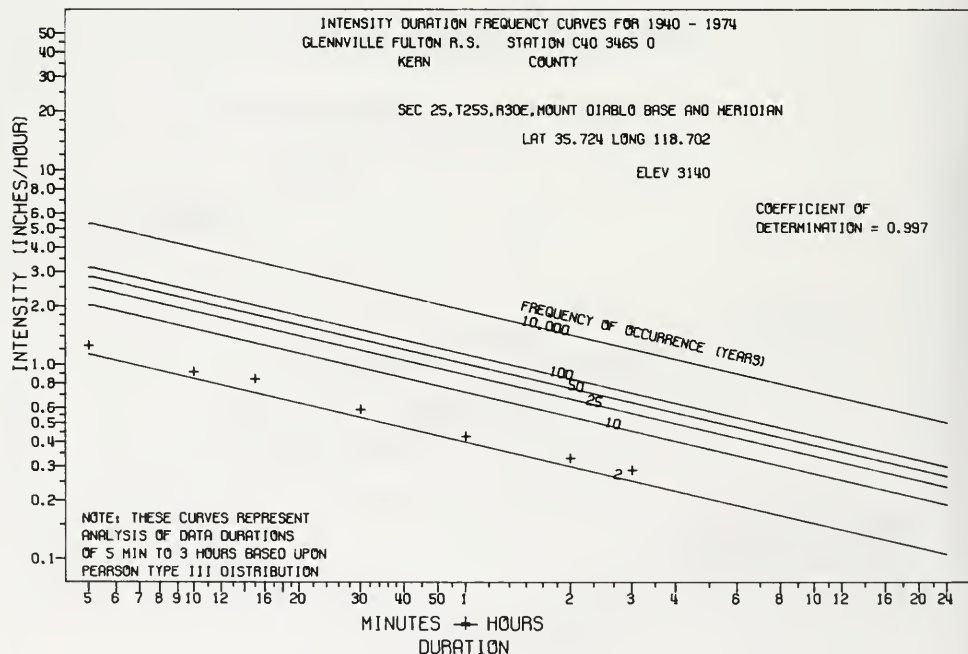
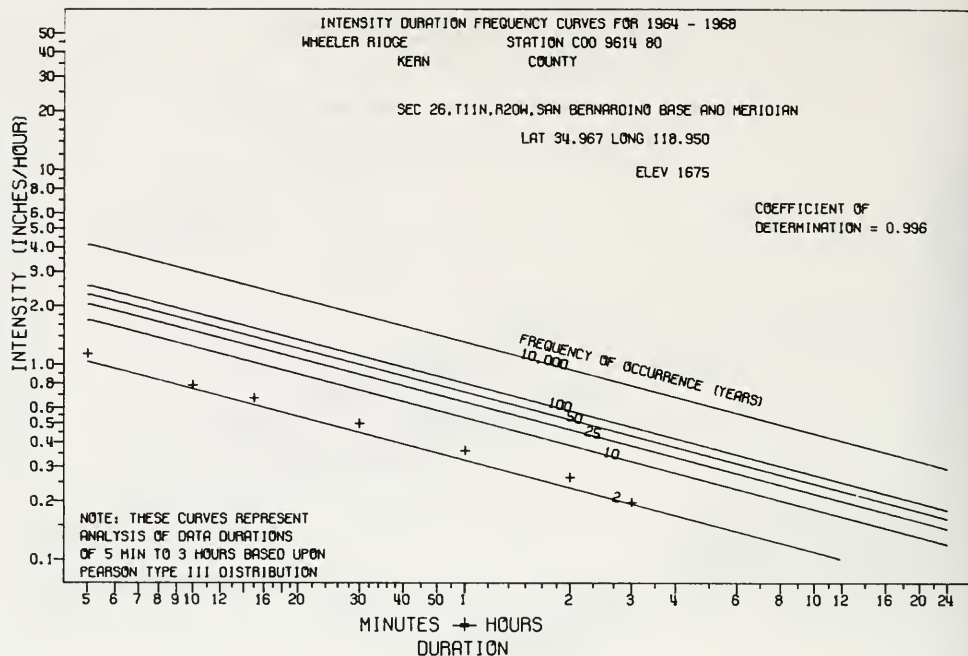


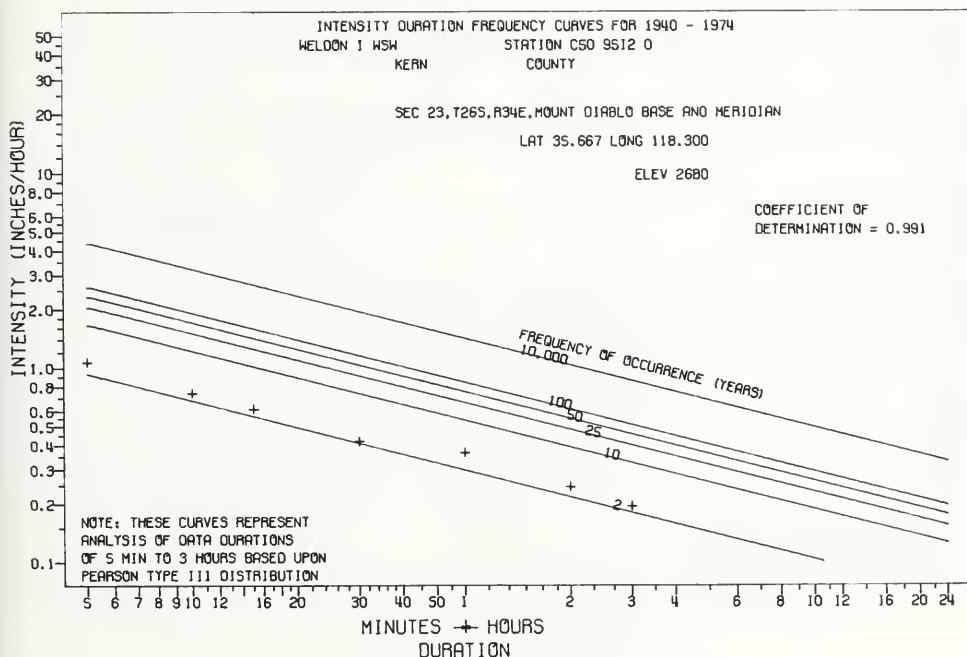
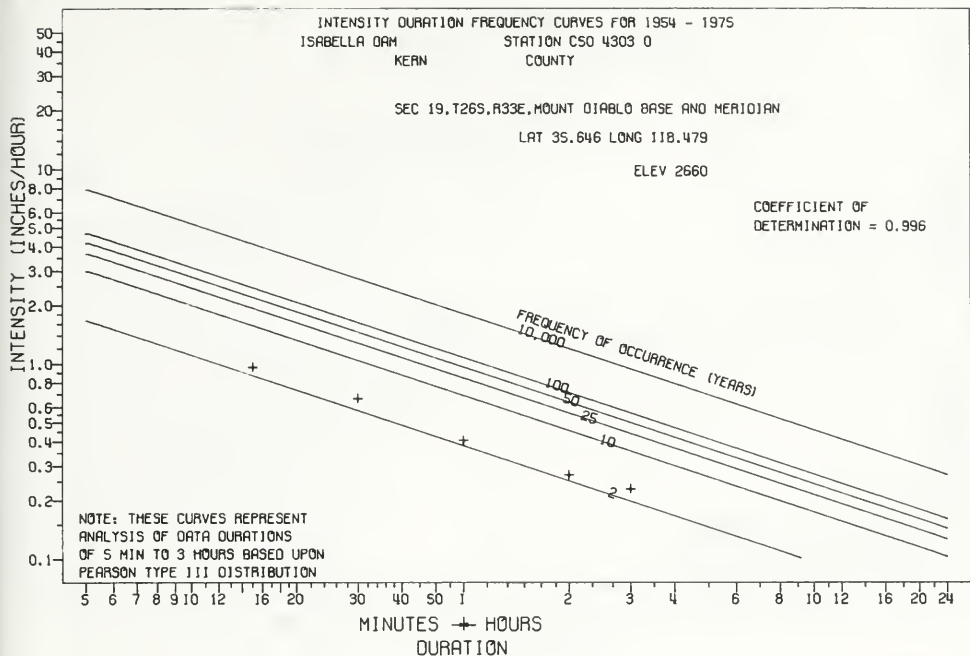




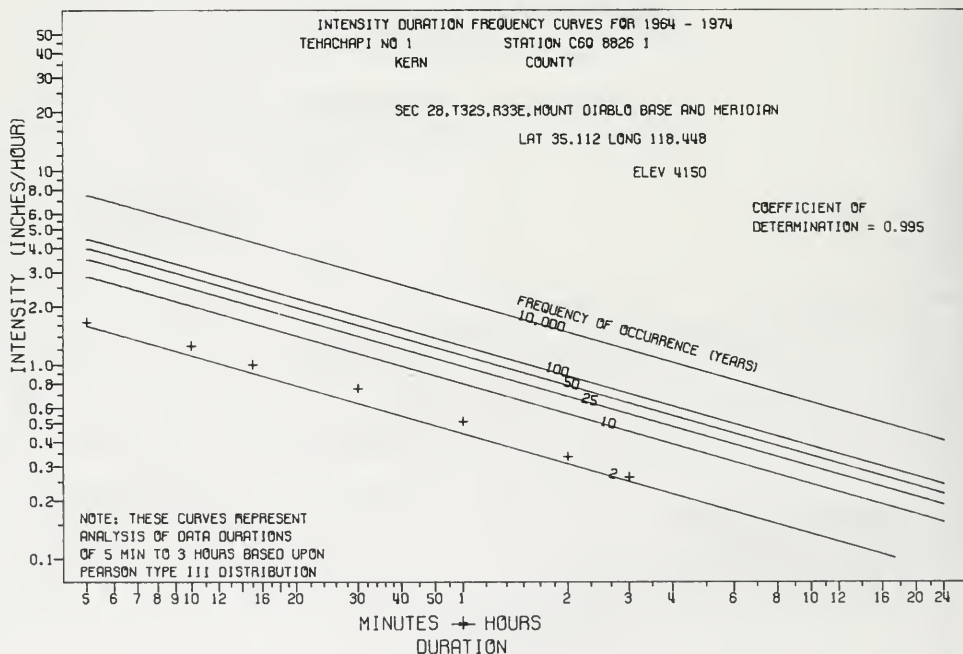
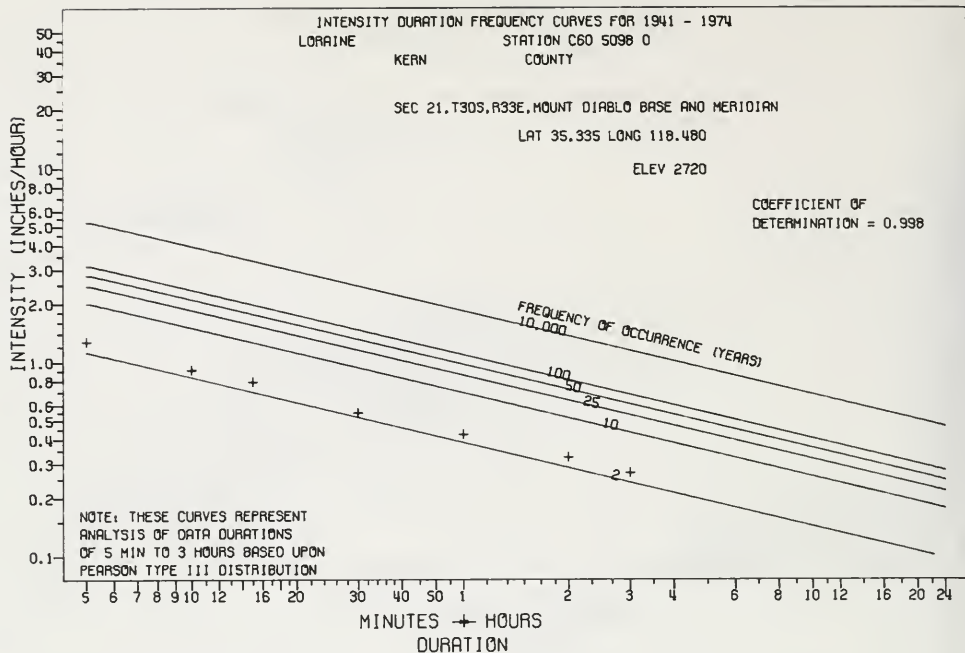




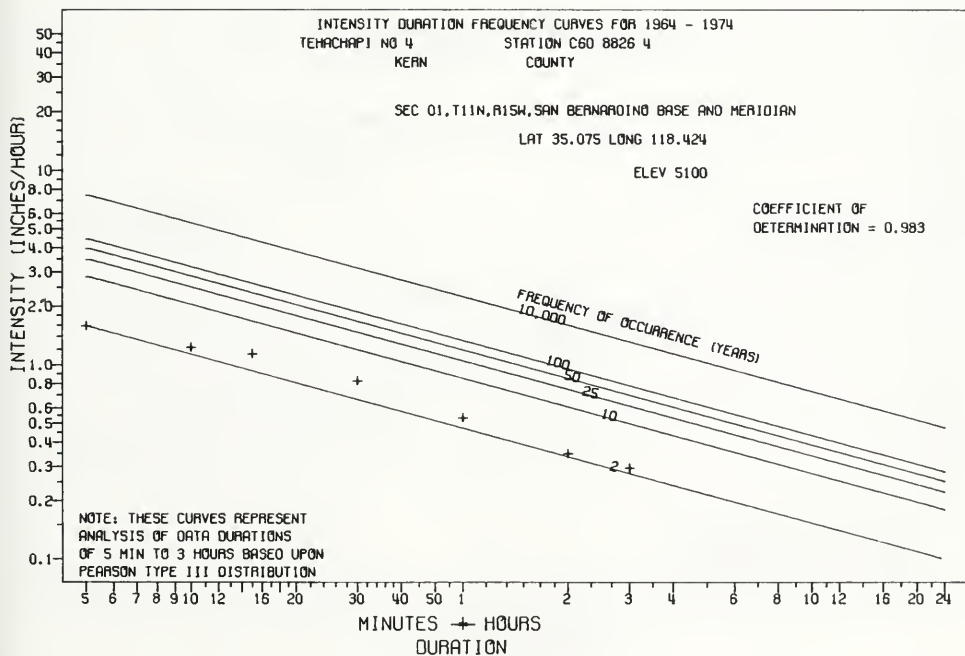
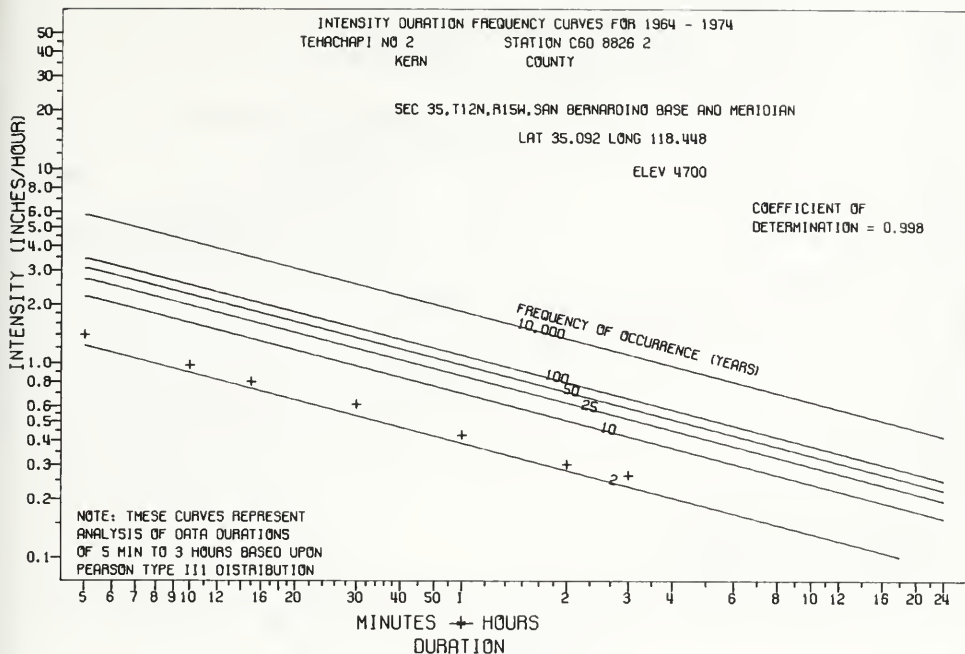


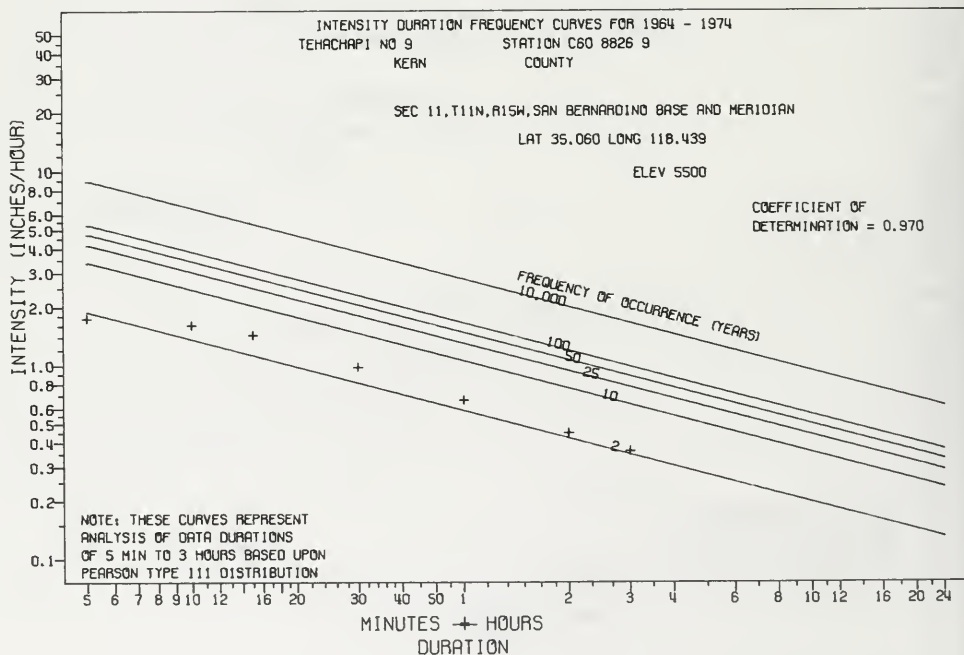
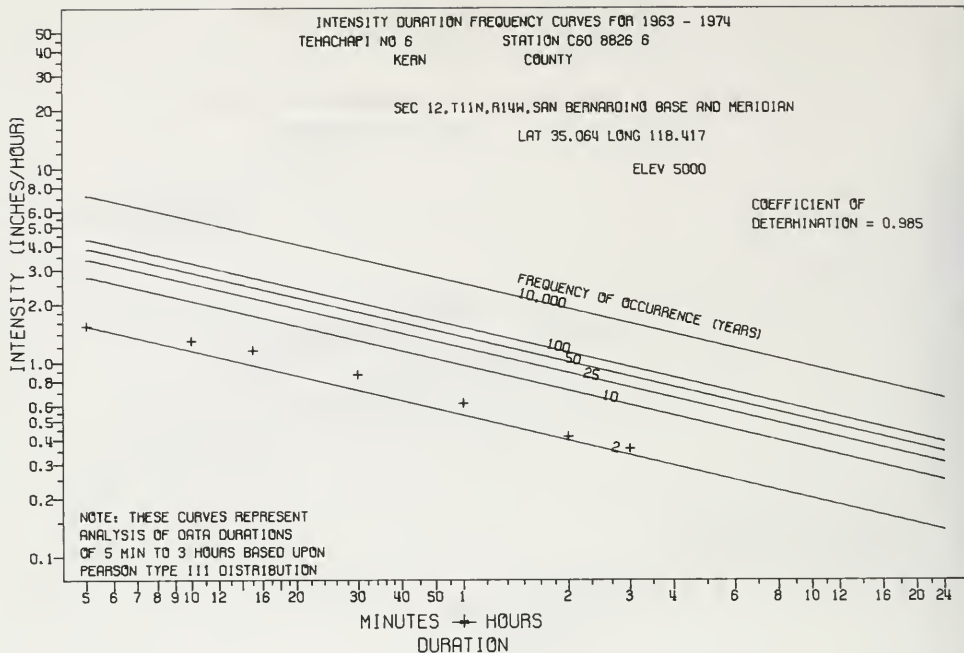


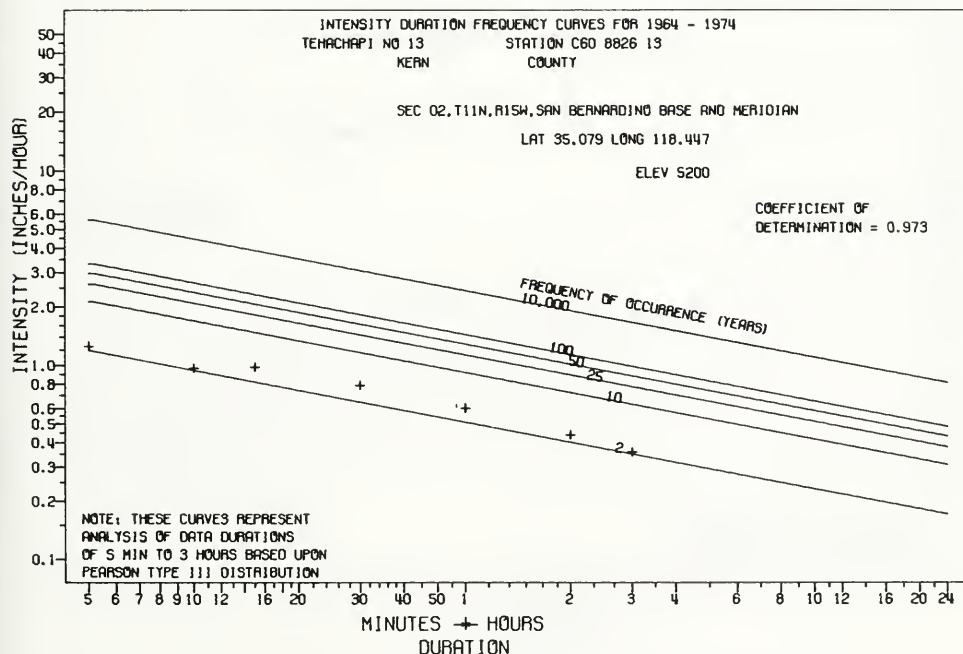
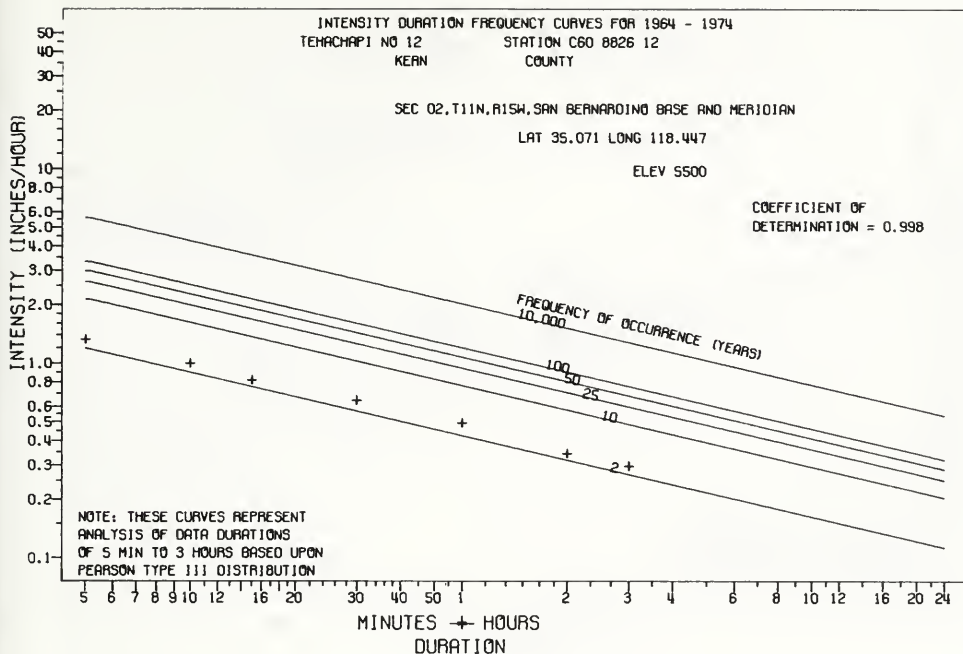


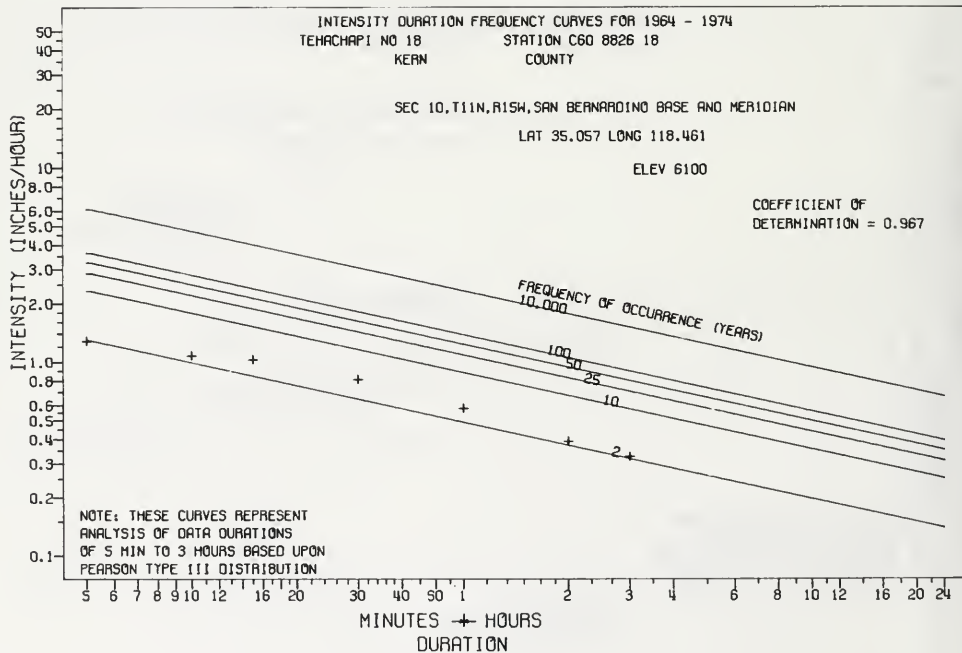
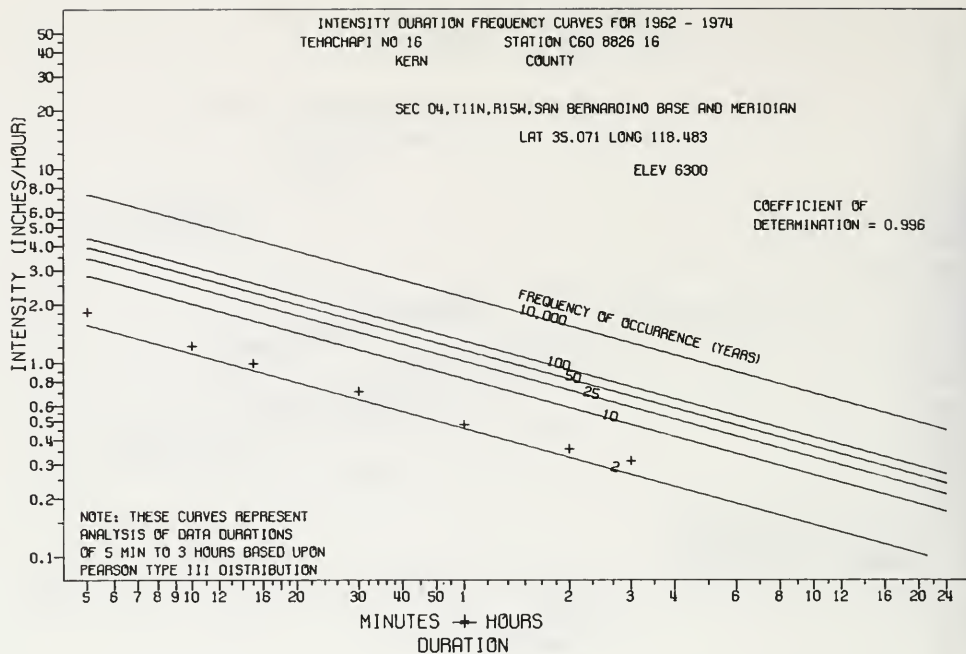


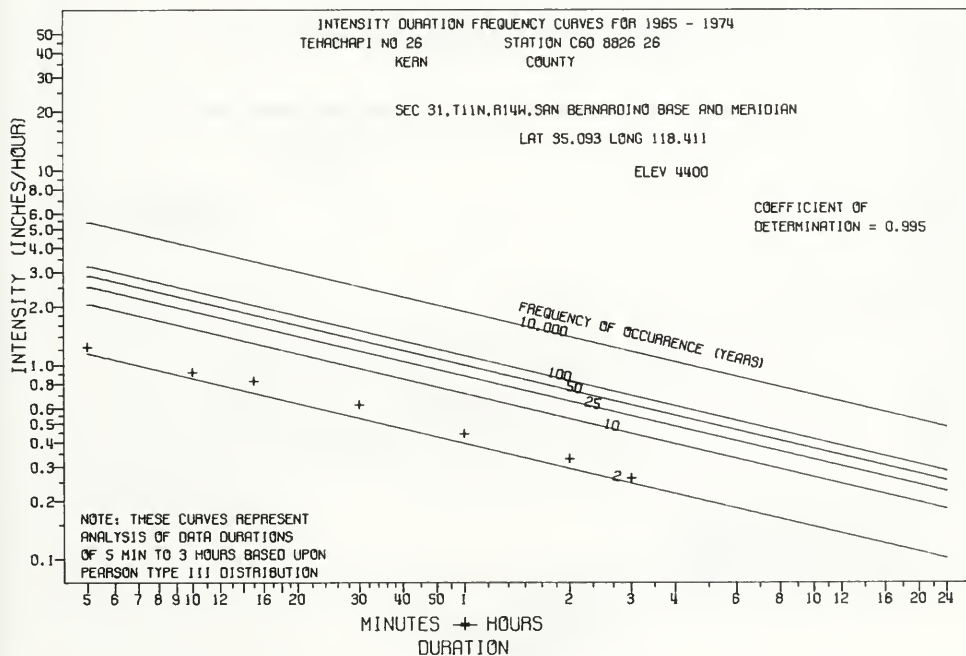
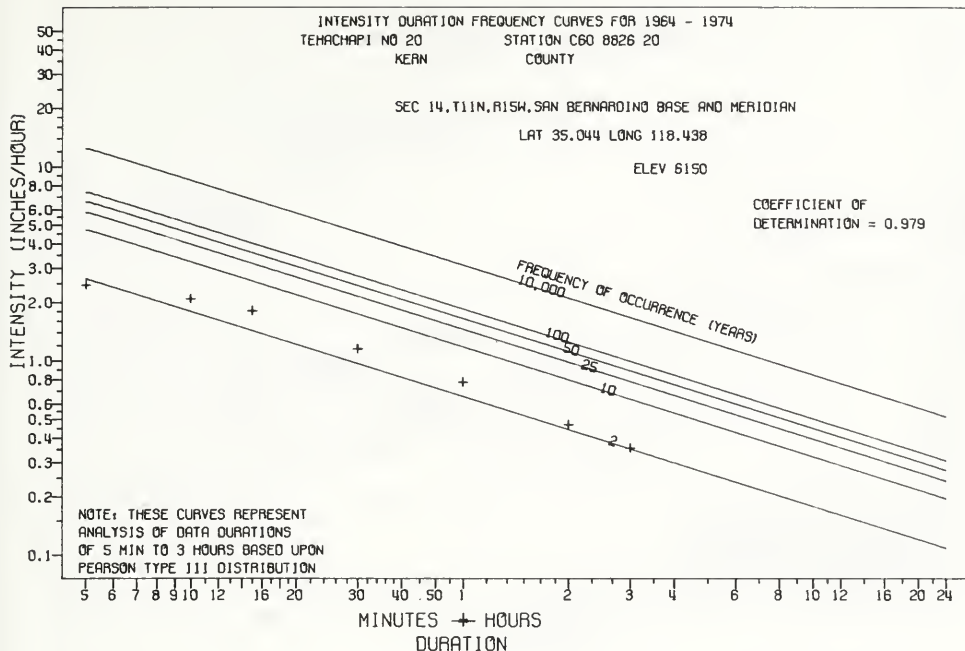


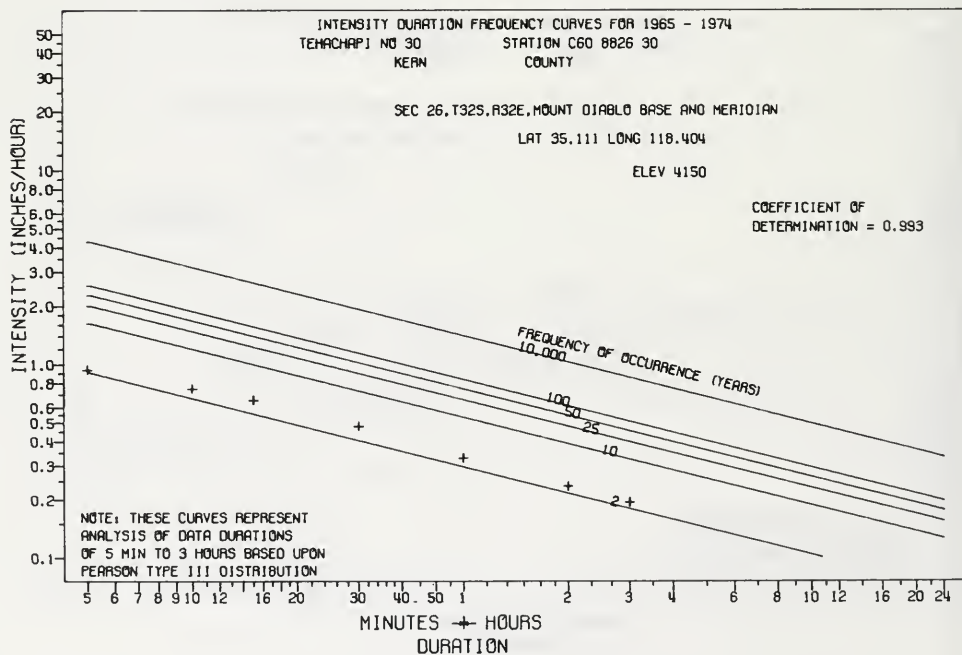
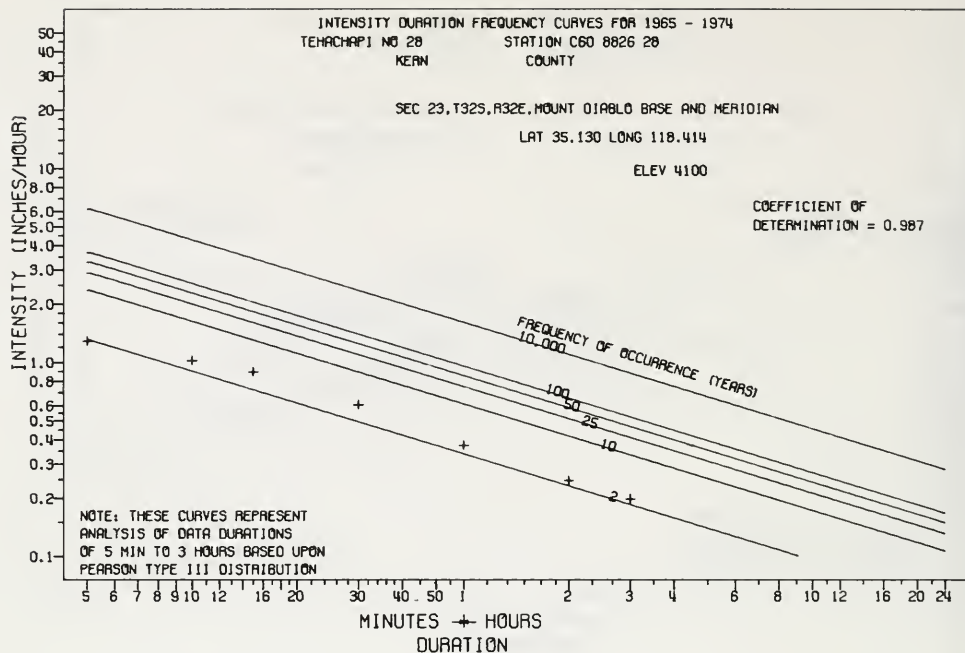


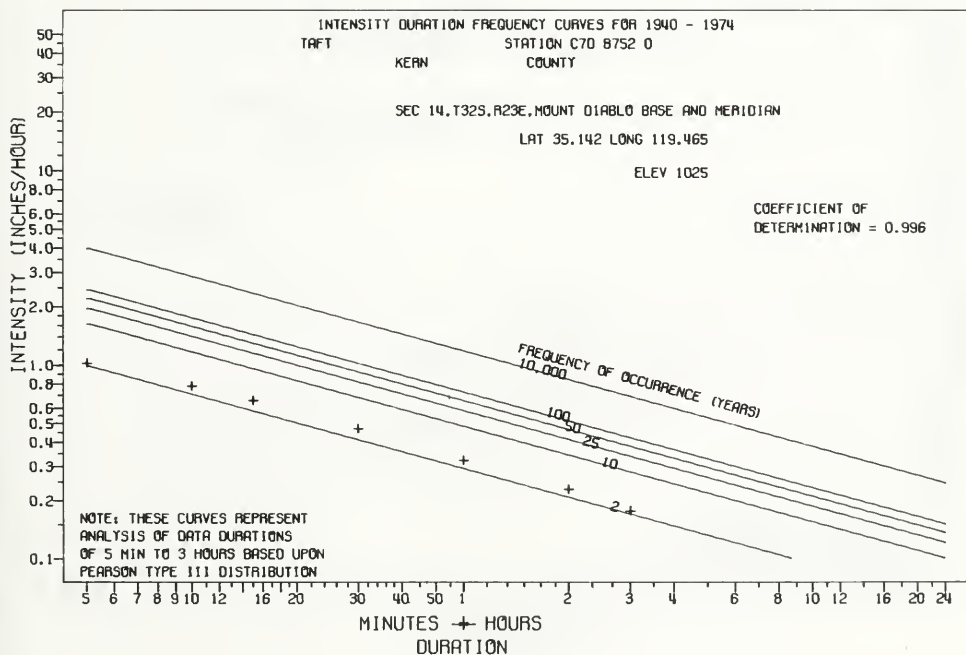
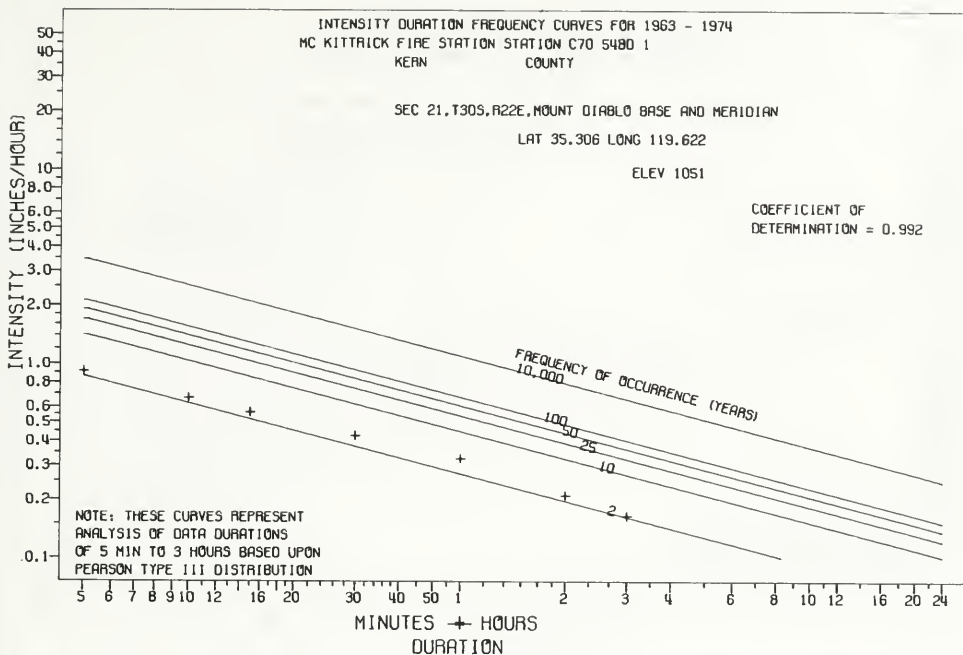




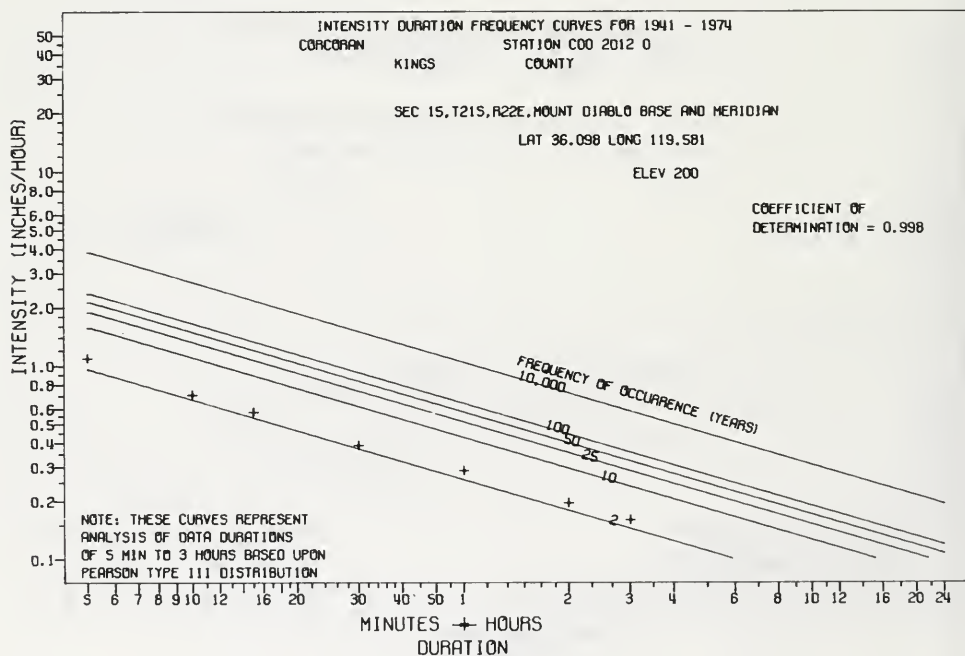
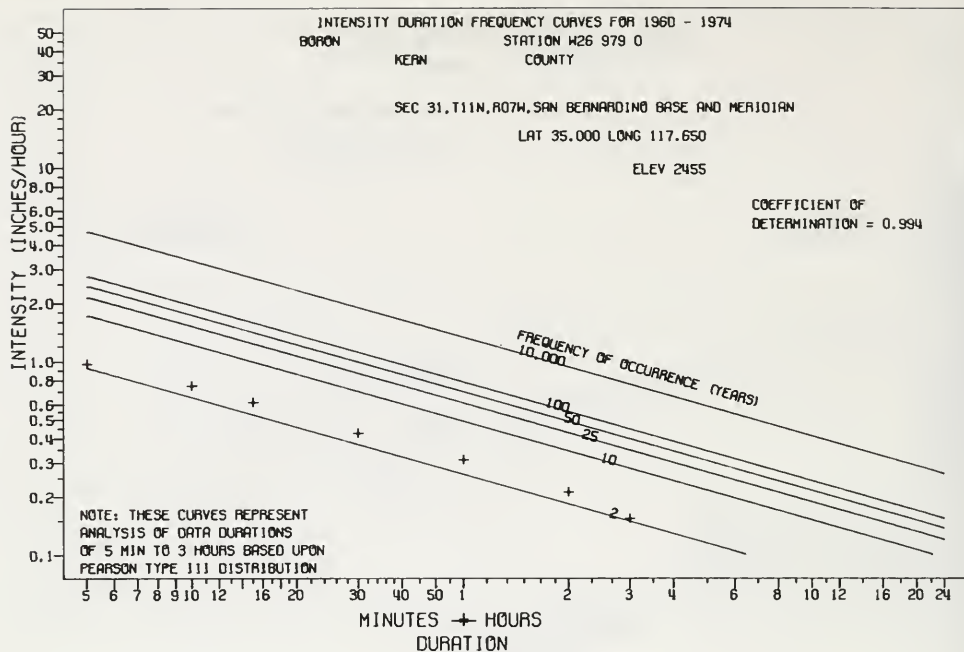




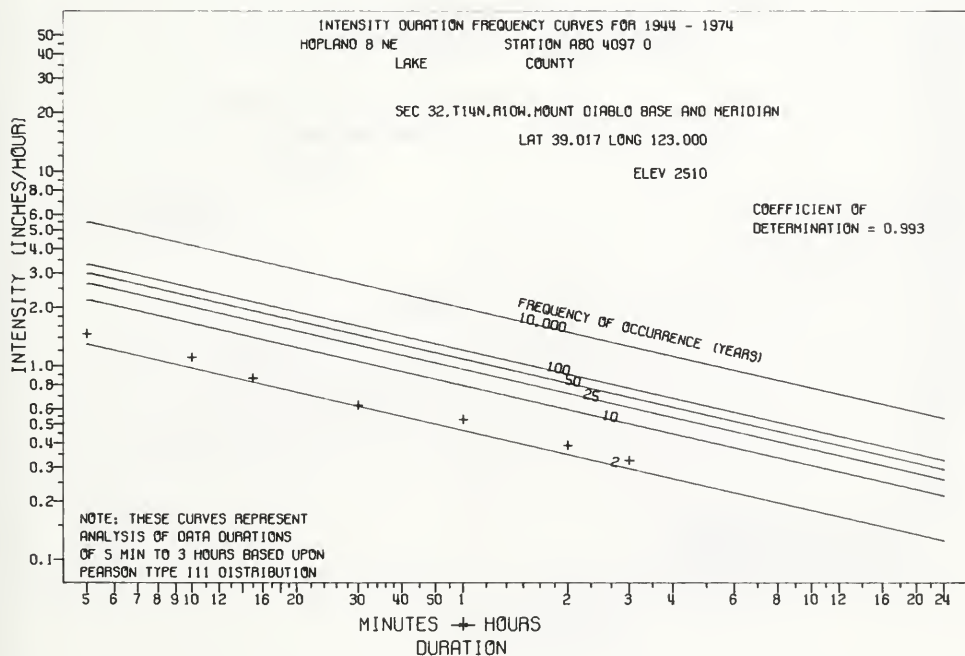
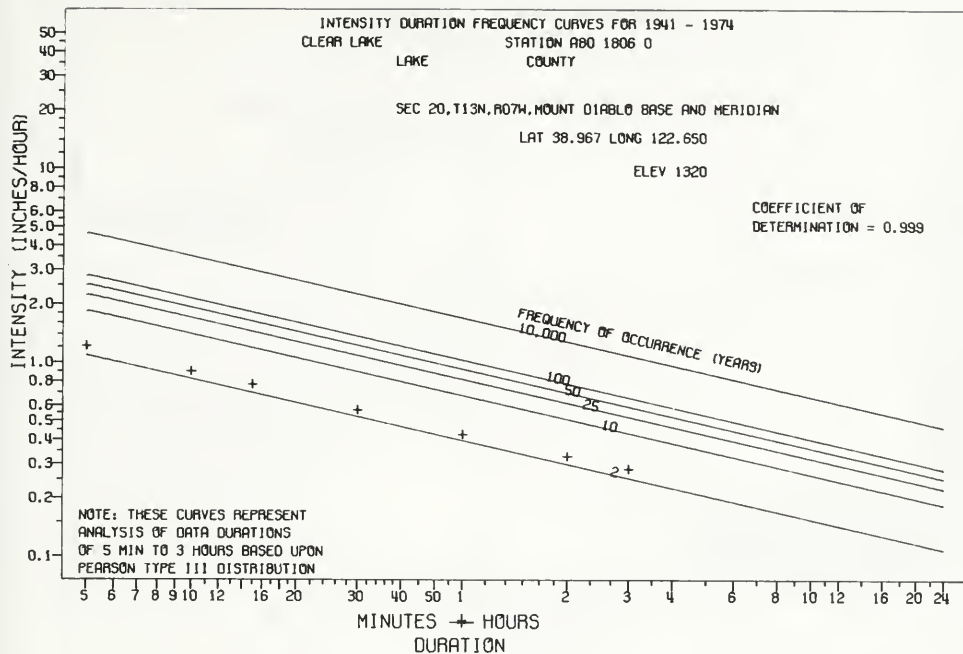


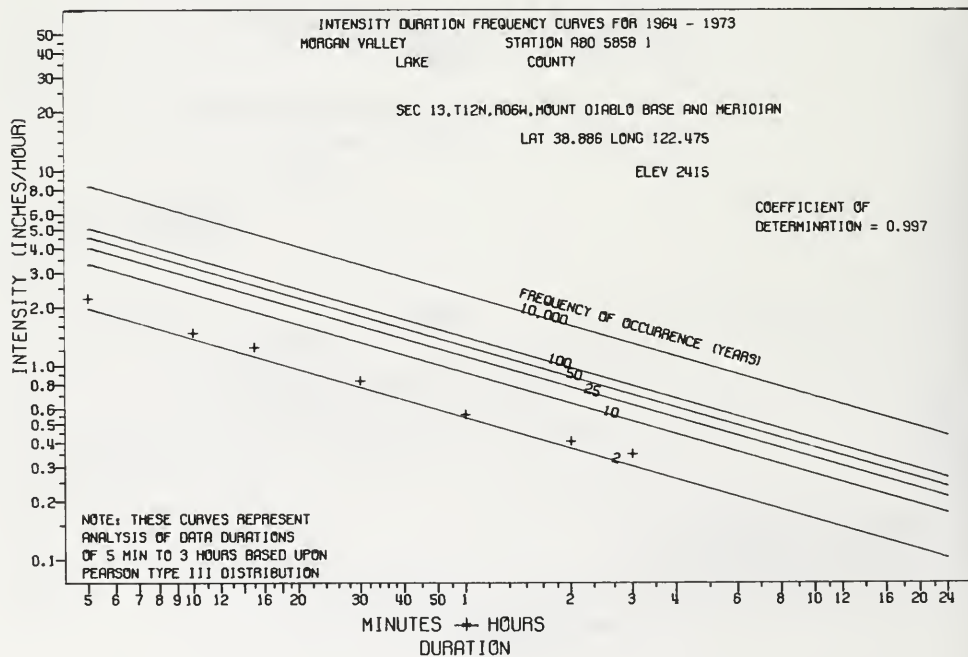
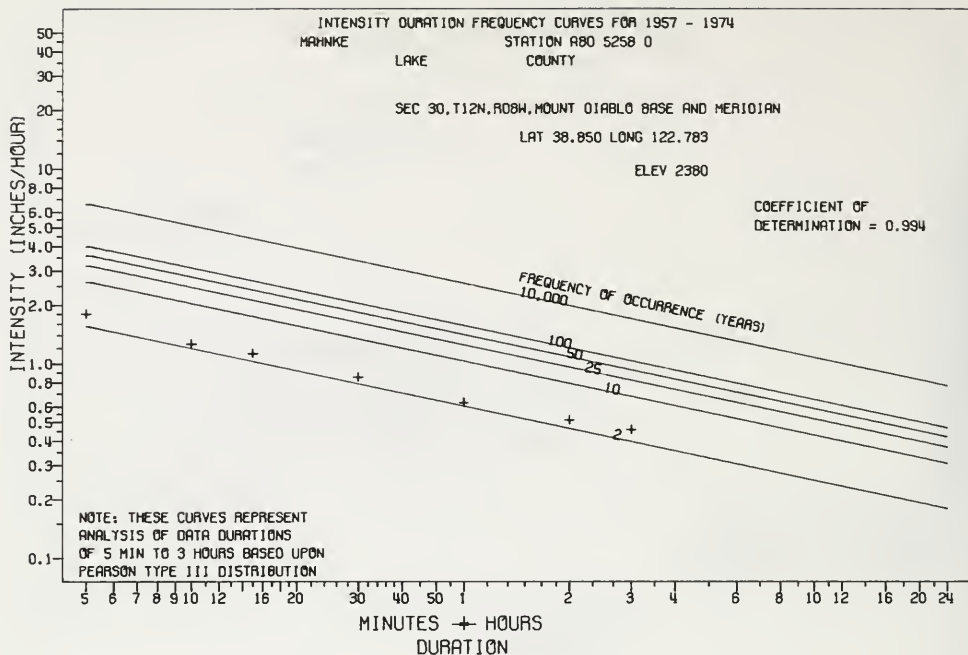


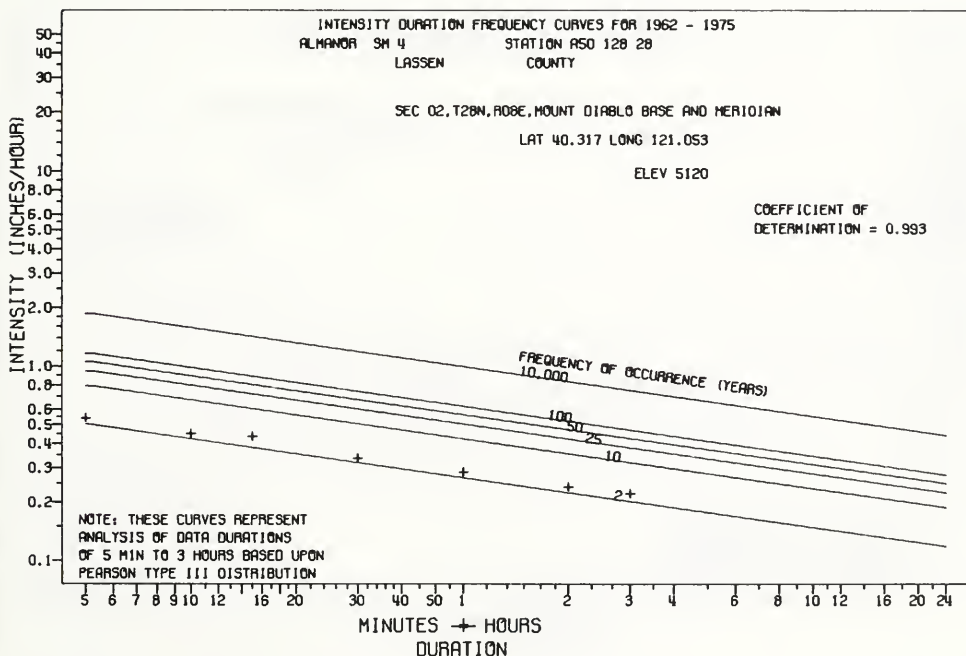
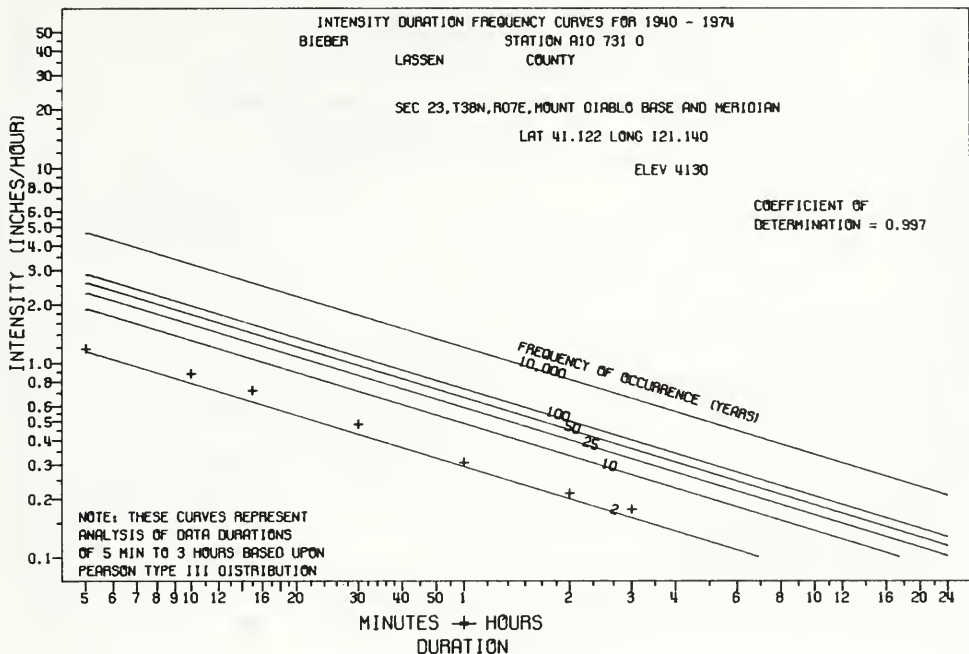


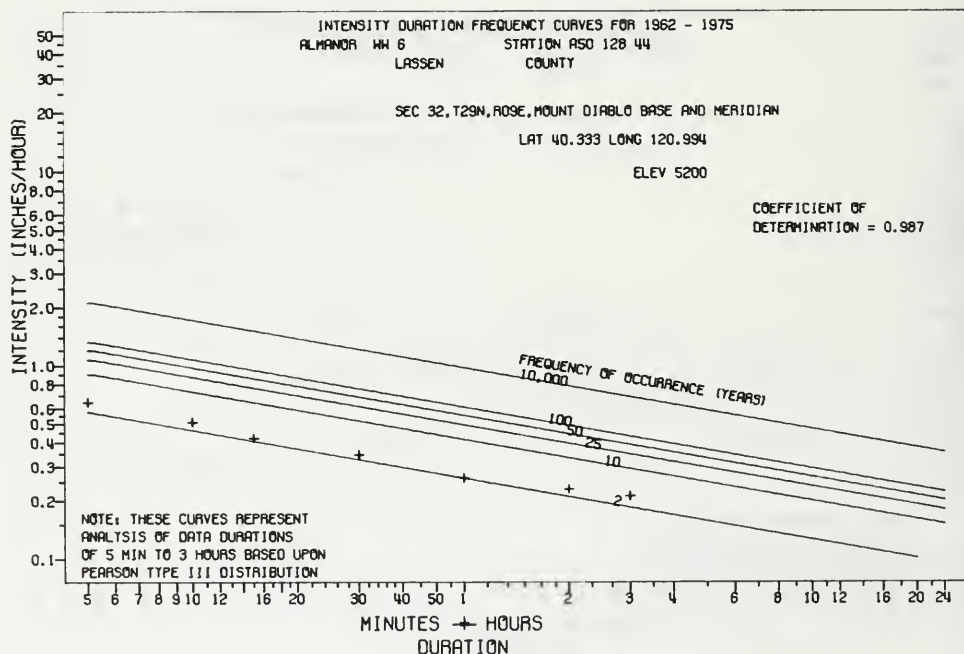
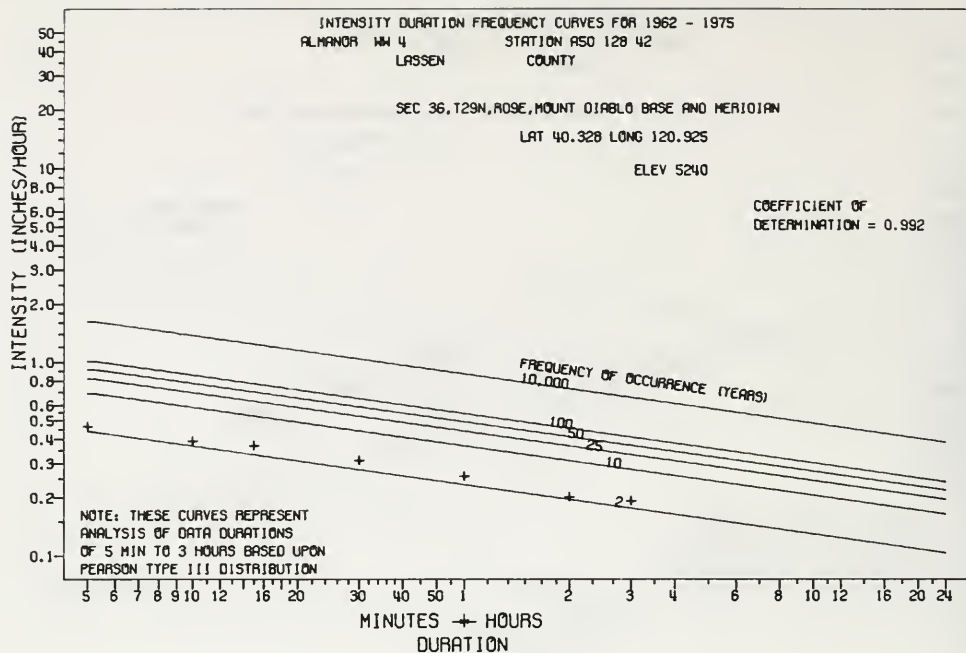


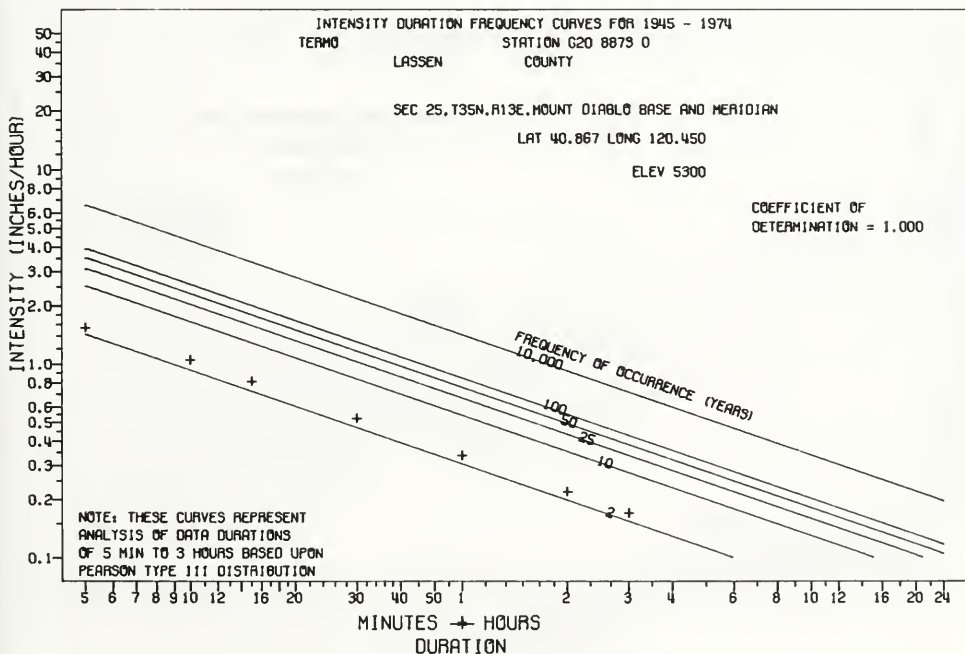
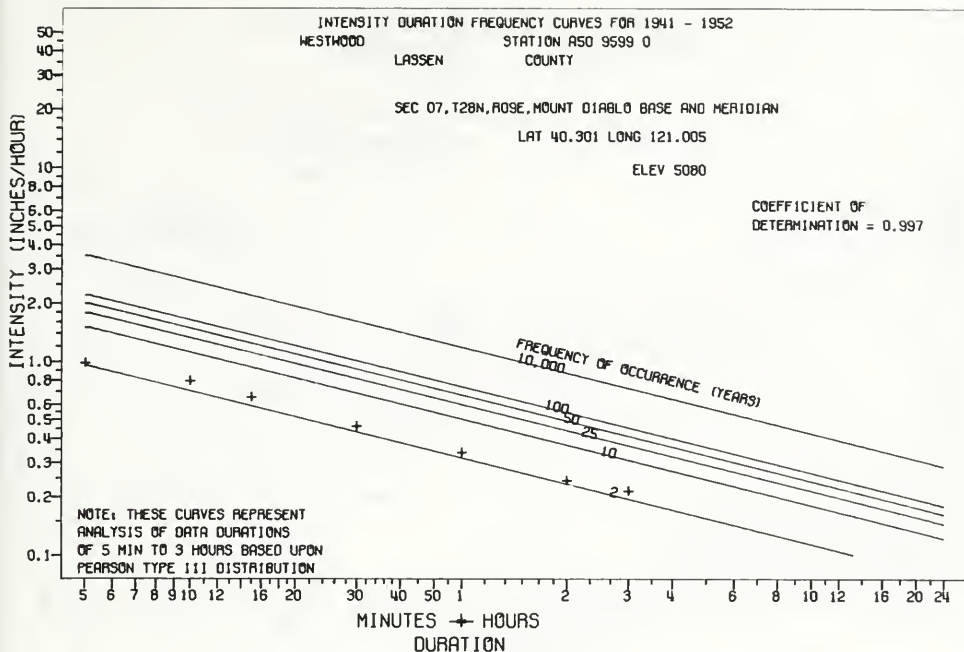


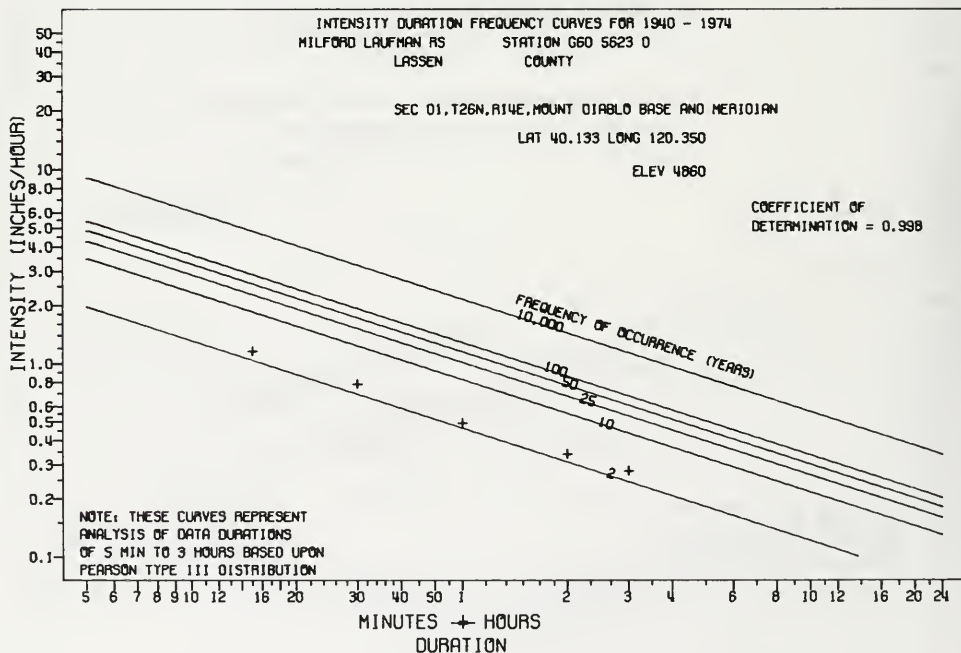
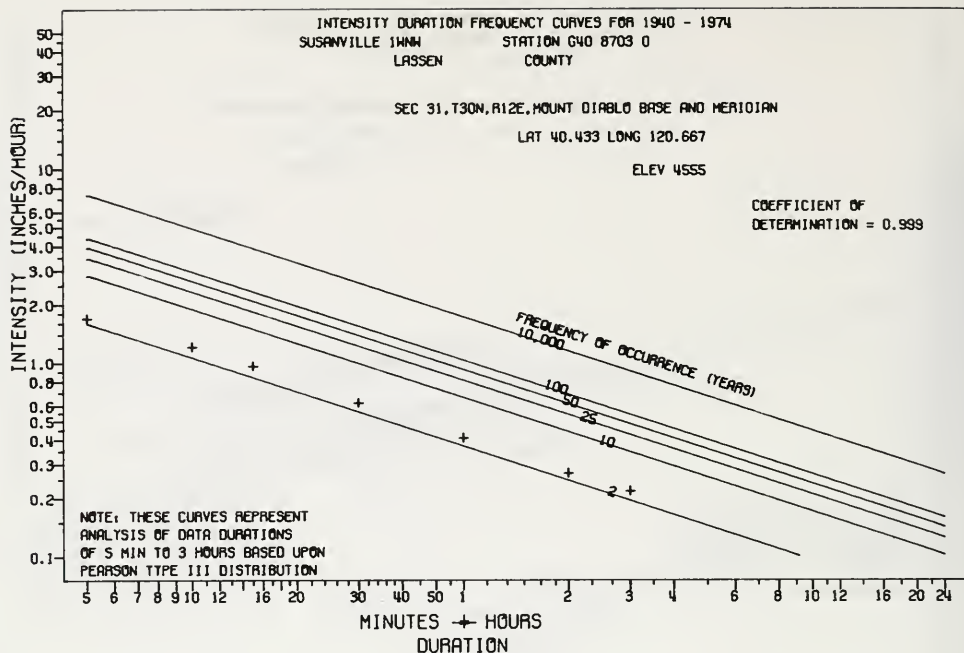


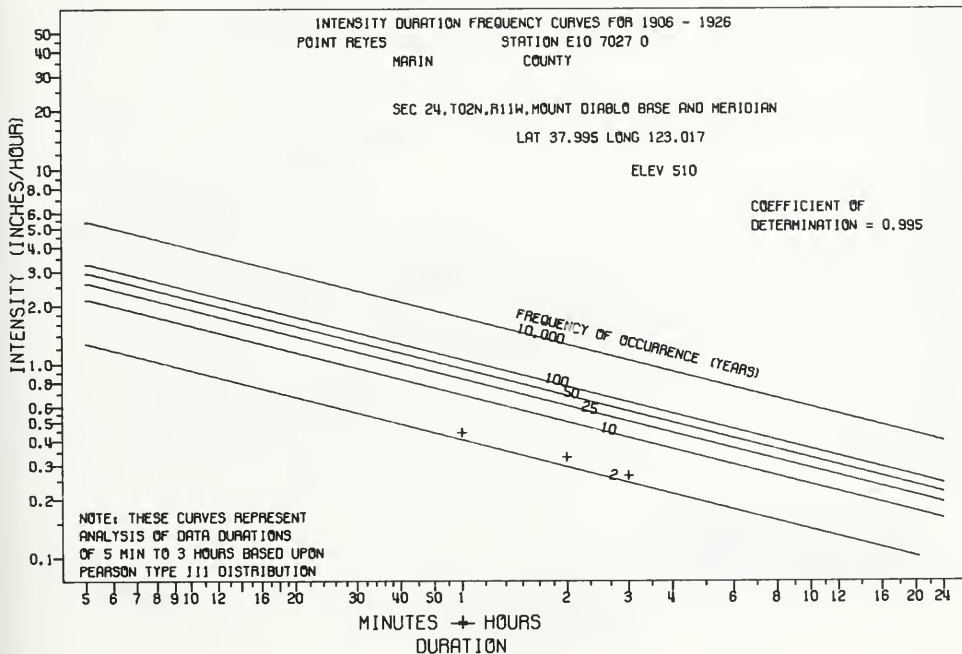
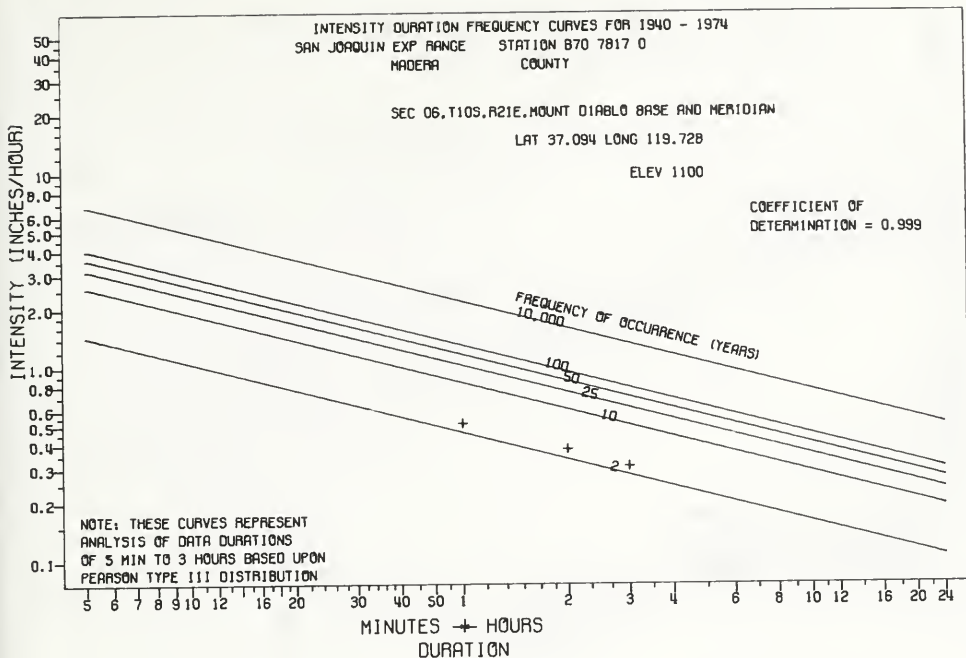




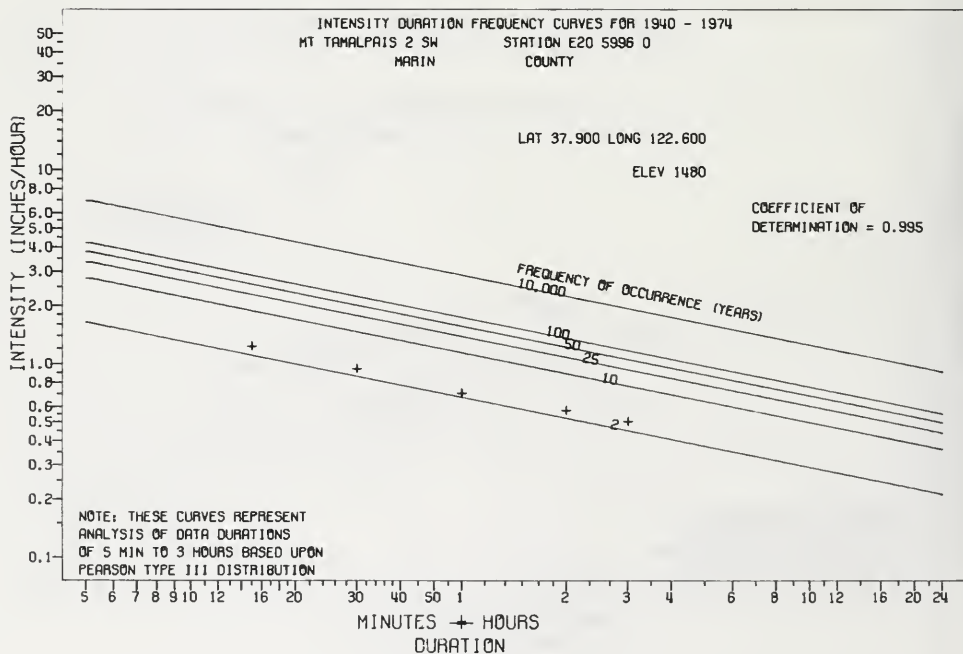
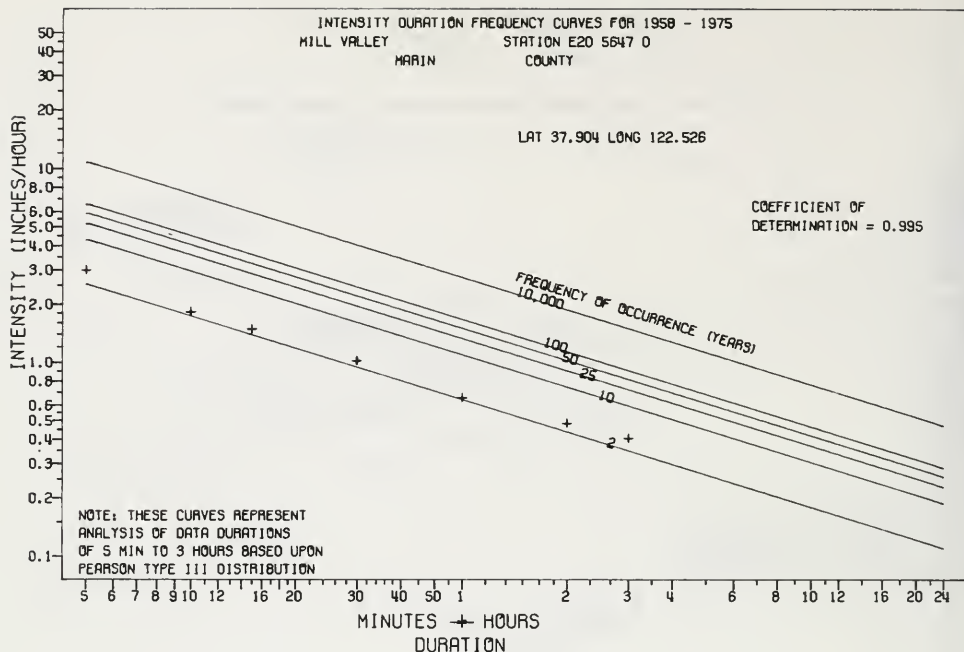




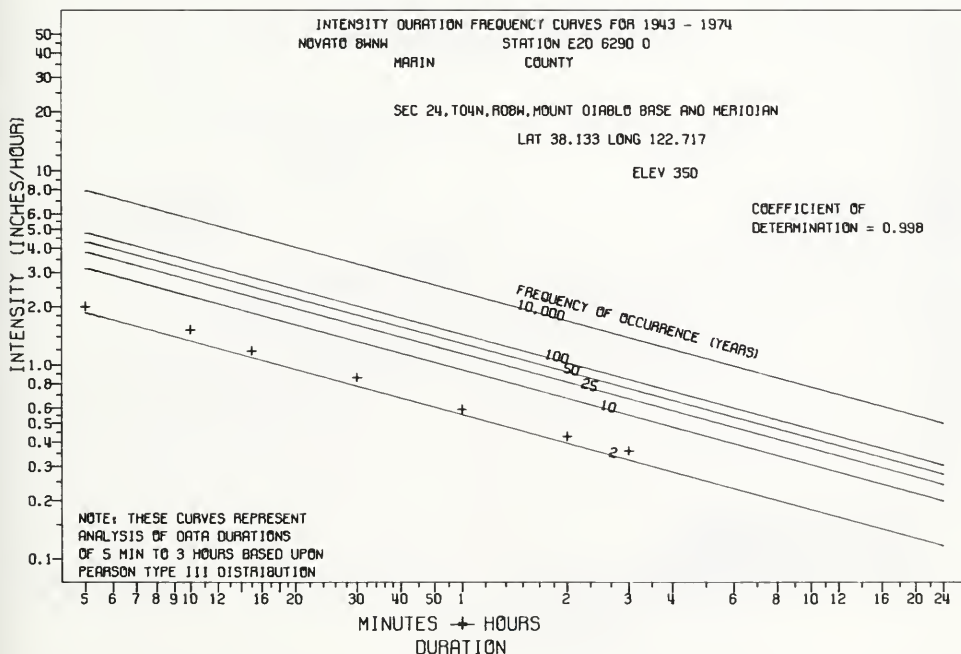
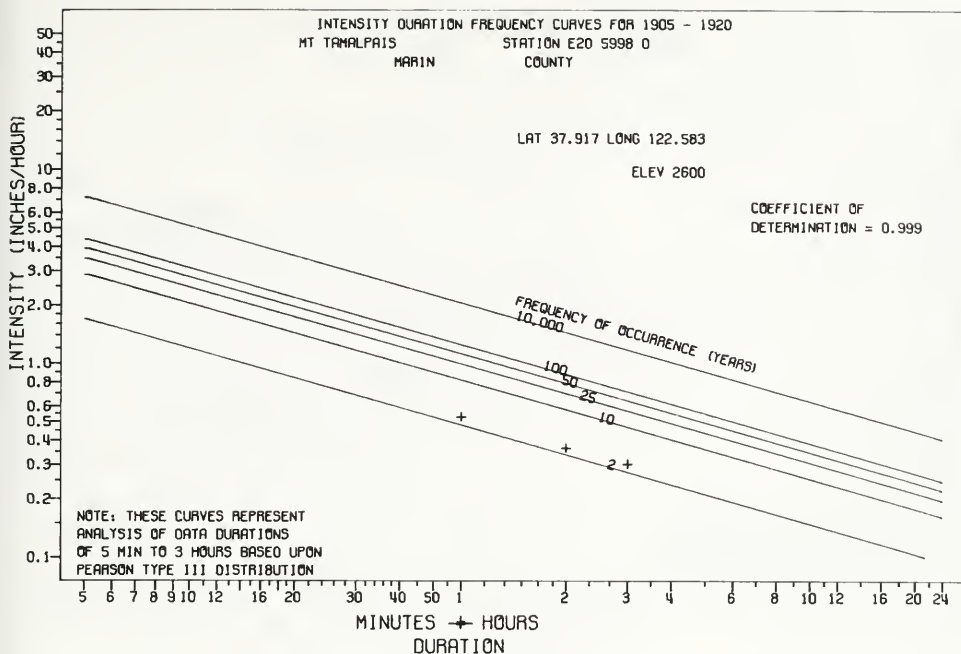


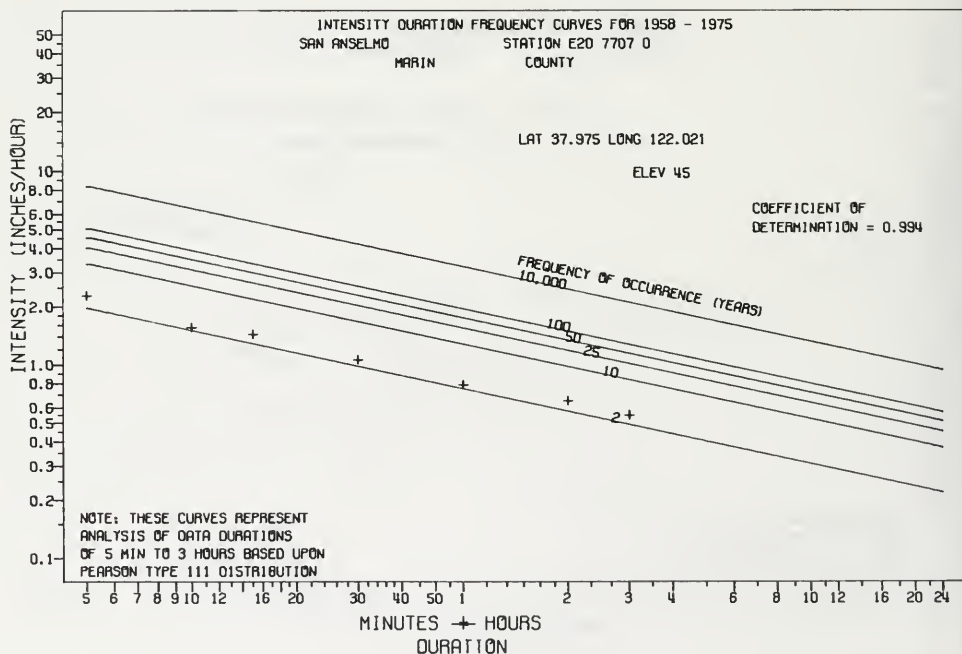
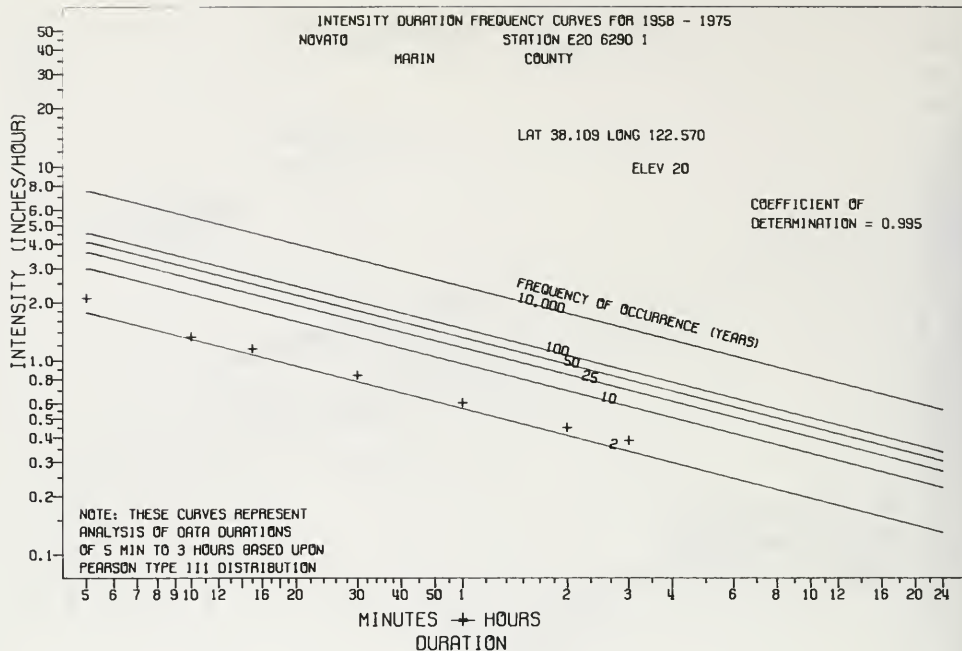


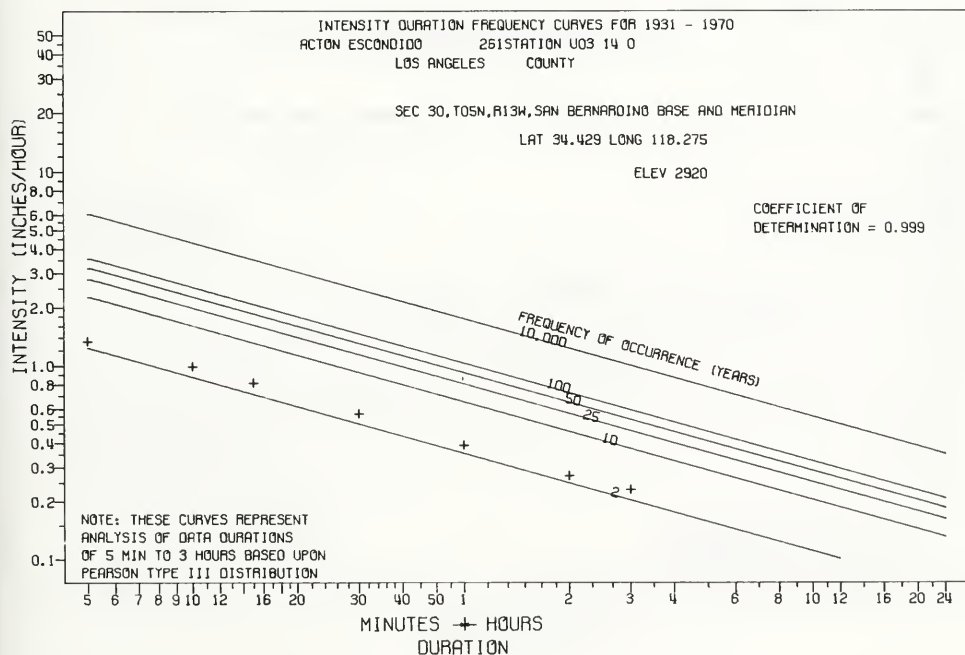
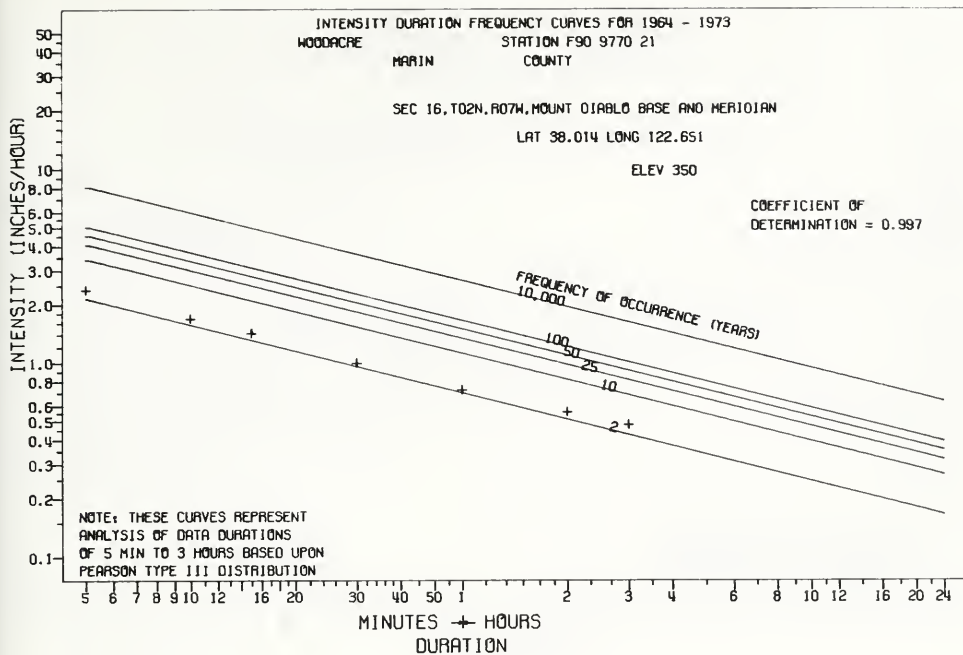


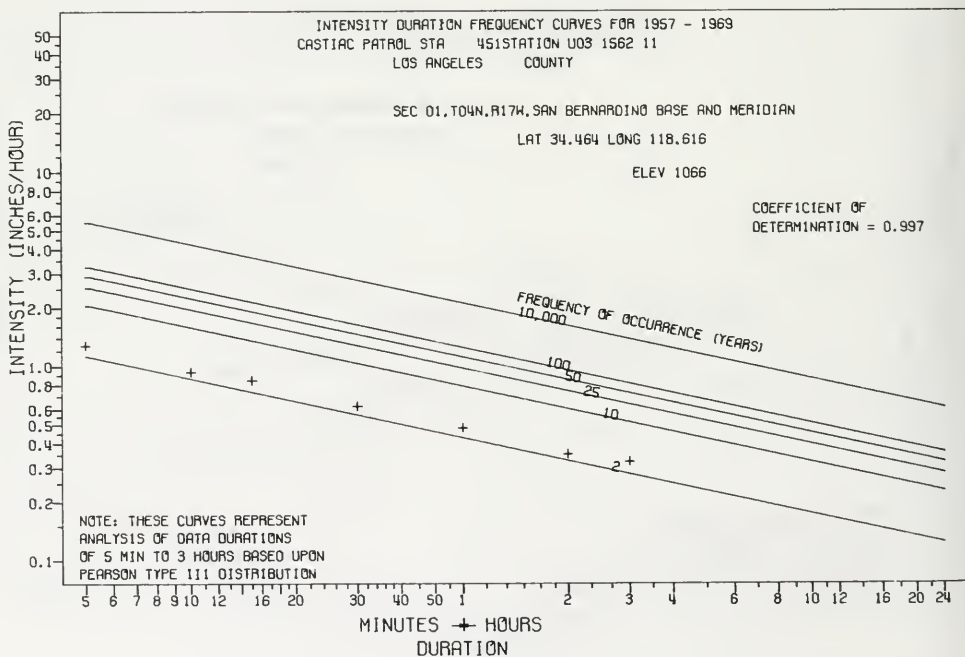
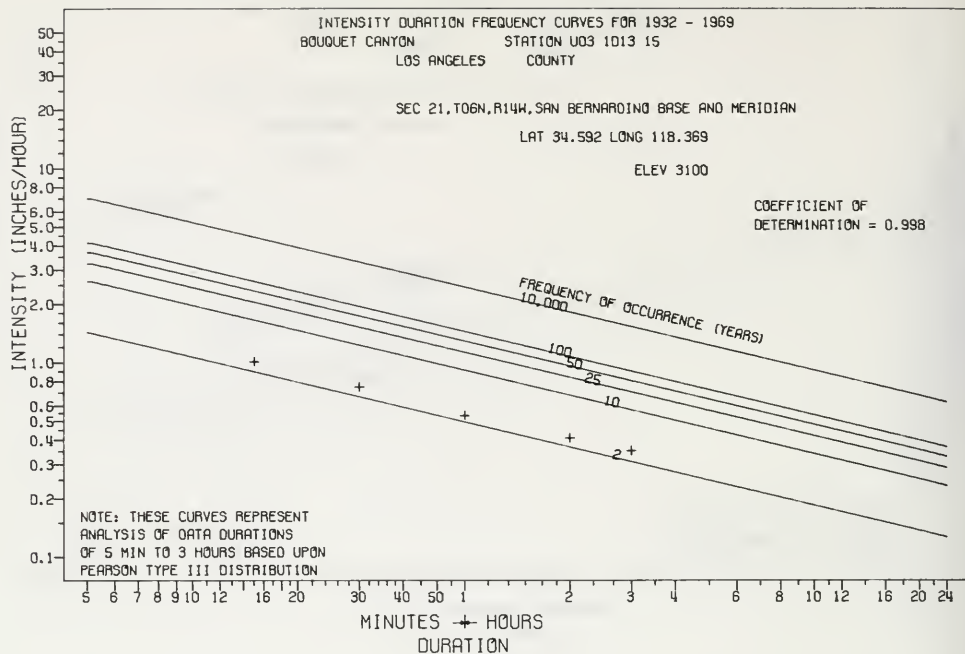












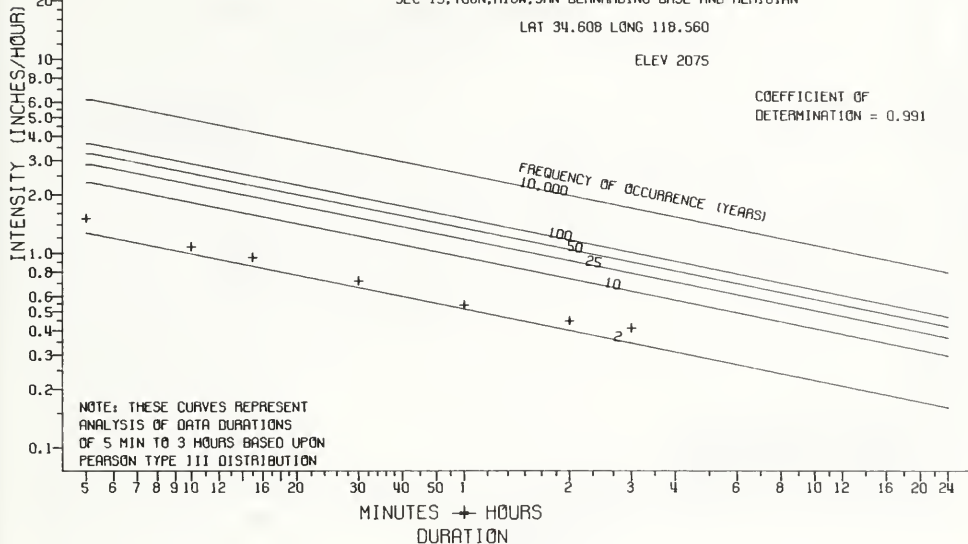
INTENSITY DURATION FREQUENCY CURVES FOR 1956 - 1971  
ELIZABETH LAKE 128 STATION U03 2735 0  
LOS ANGELES COUNTY

SEC 15, T06N, R16W, SAN BERNARDINO BASE AND MERIDIAN

LAT 34.608 LONG 118.560

ELEV 2075

COEFFICIENT OF  
DETERMINATION = 0.991

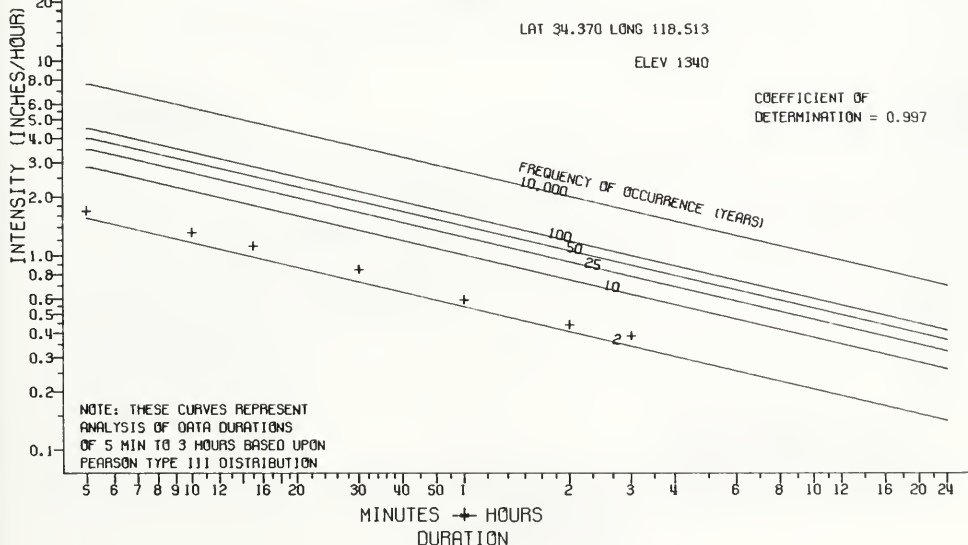


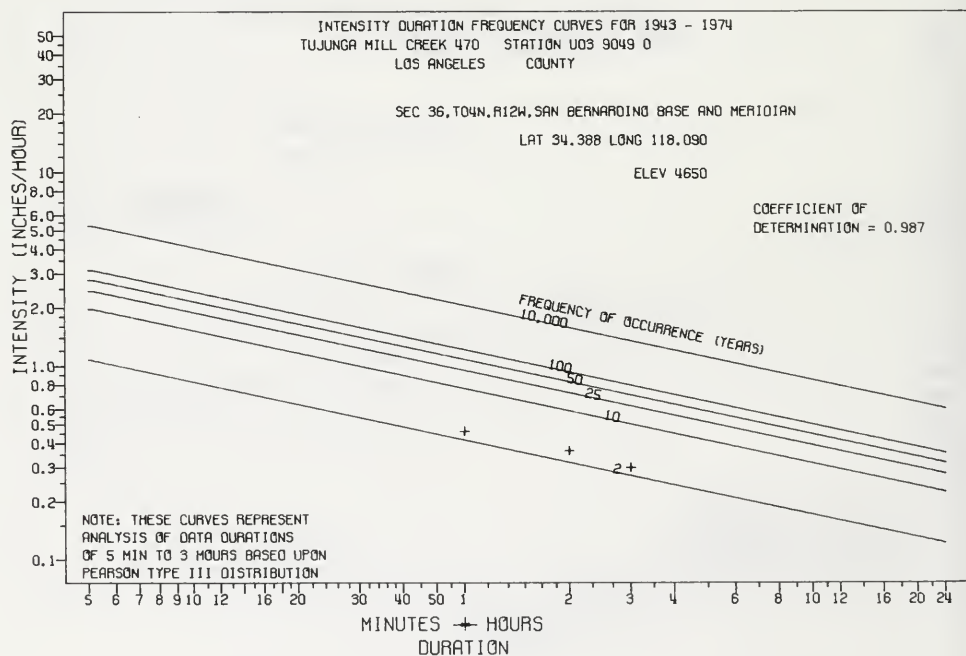
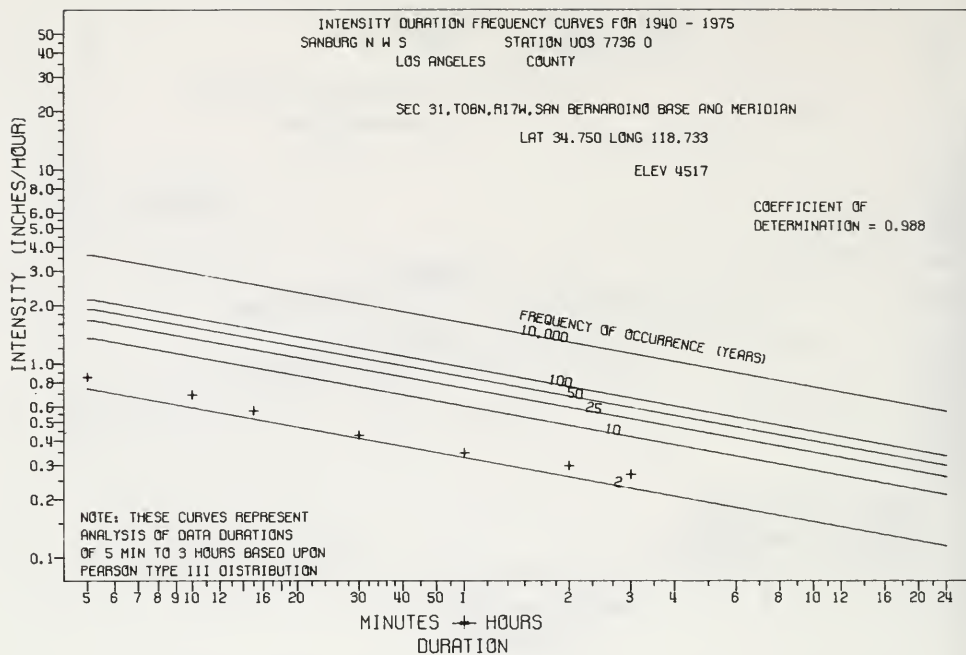
INTENSITY DURATION FREQUENCY CURVES FOR 1940 - 1974  
NEWMALL RANGER STATION STATION U03 6164 0  
LOS ANGELES COUNTY

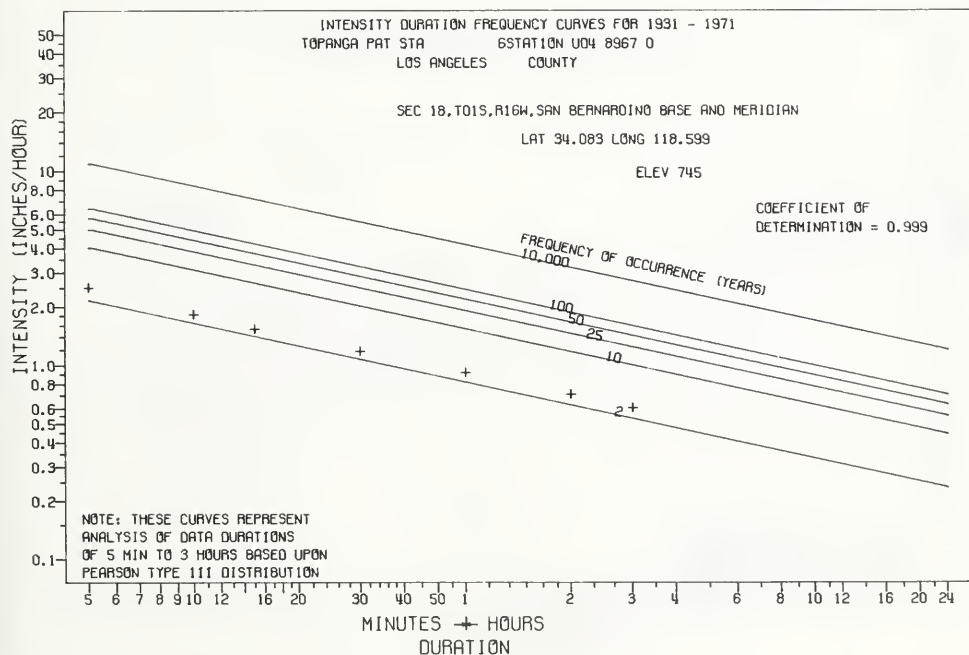
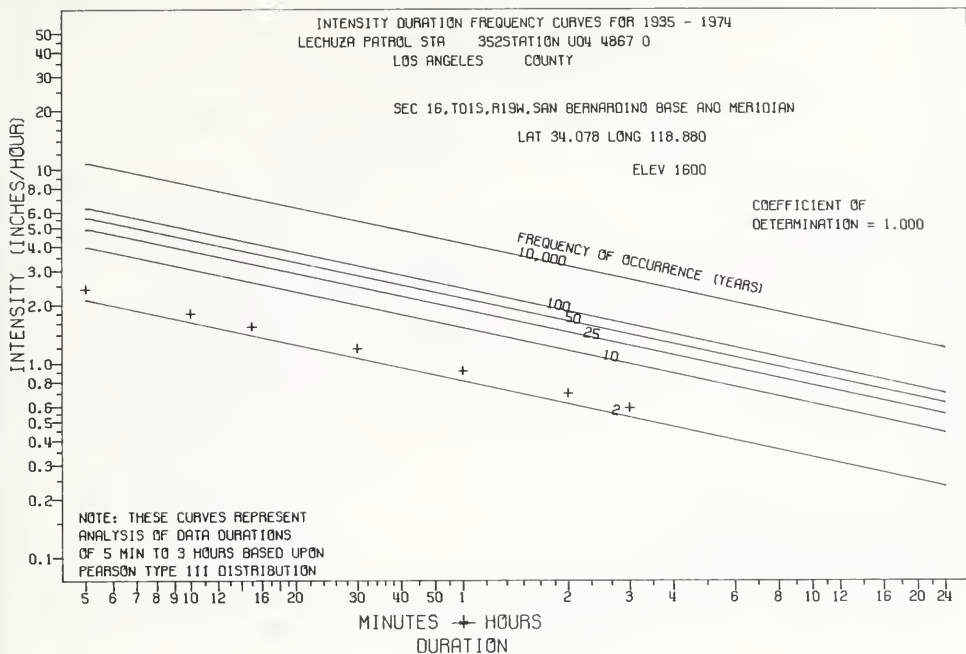
LAT 34.370 LONG 118.513

ELEV 1340

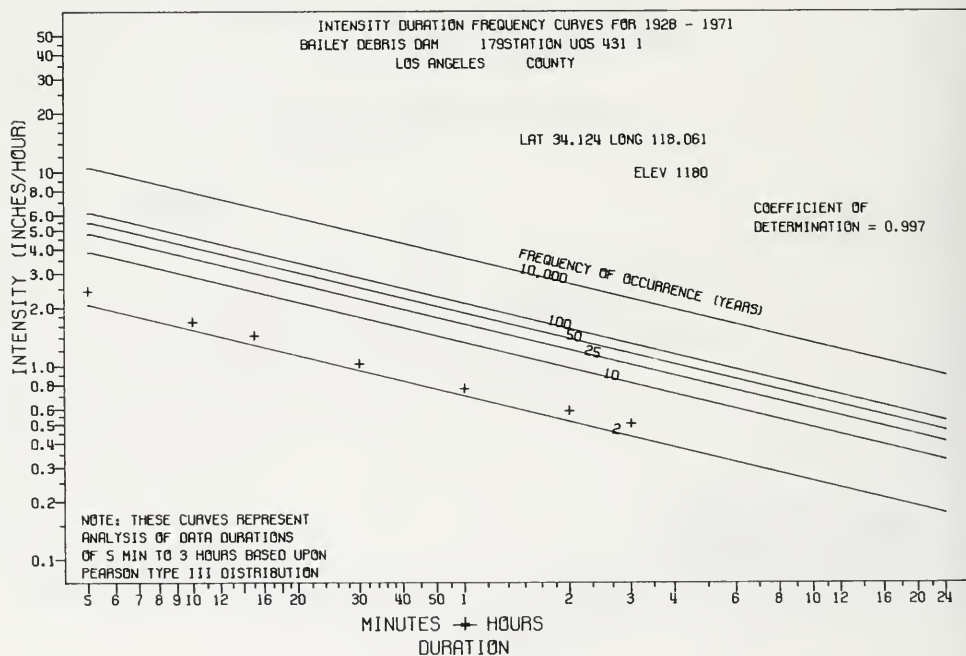
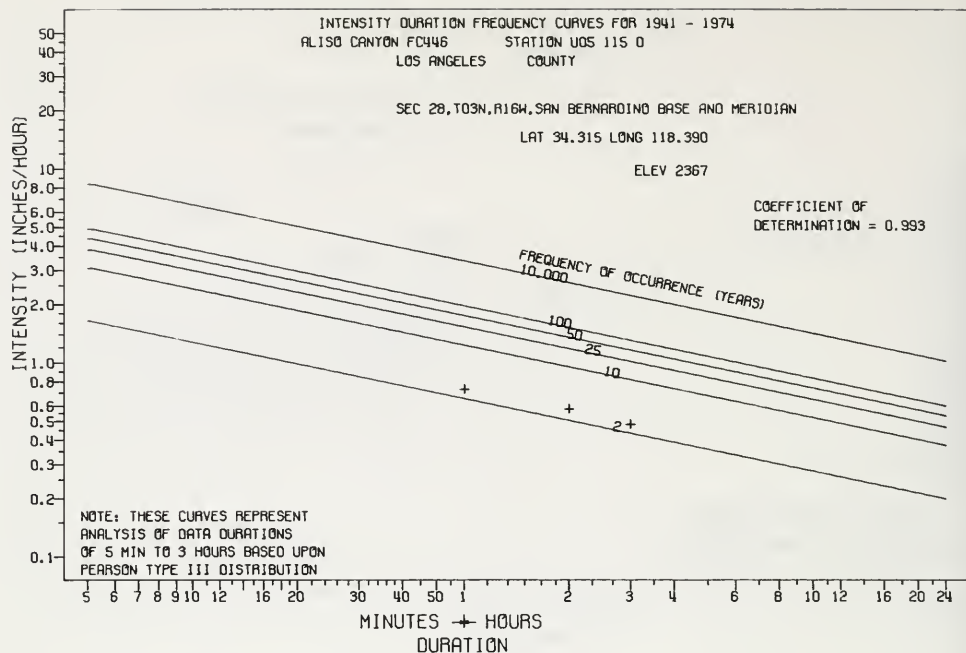
COEFFICIENT OF  
DETERMINATION = 0.997



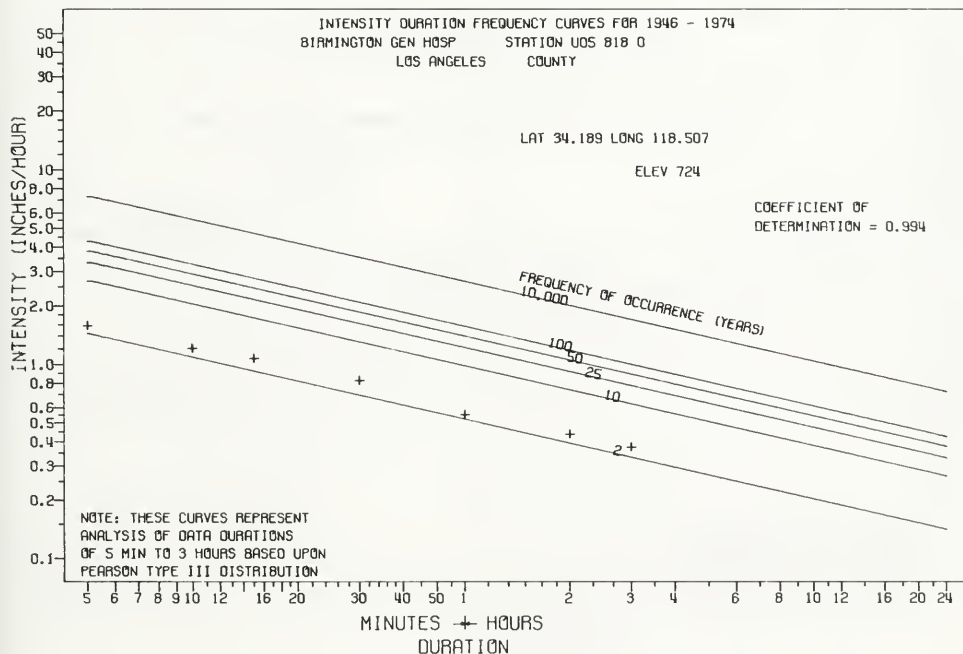
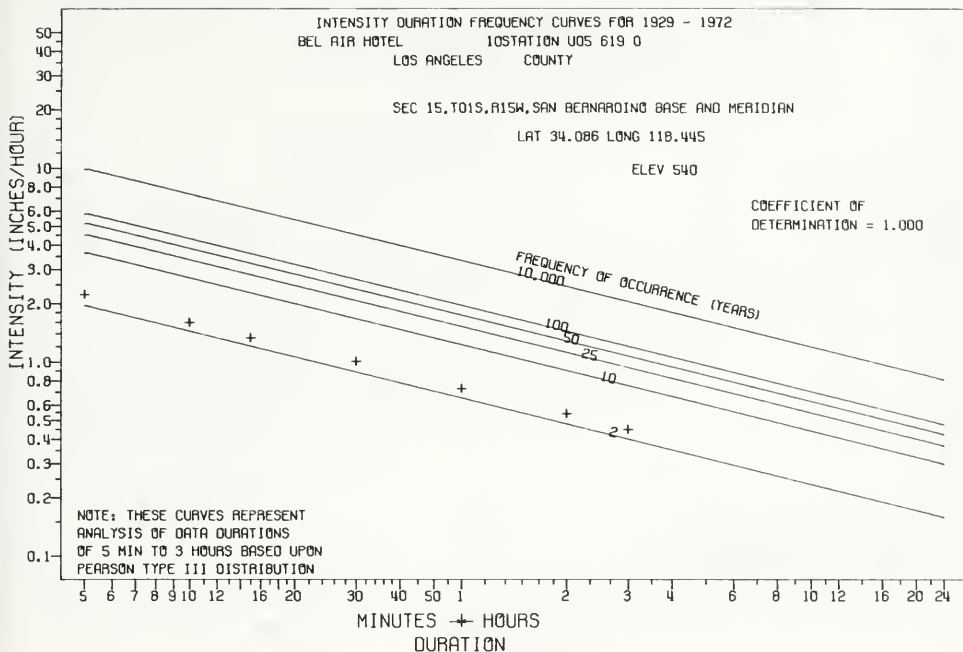


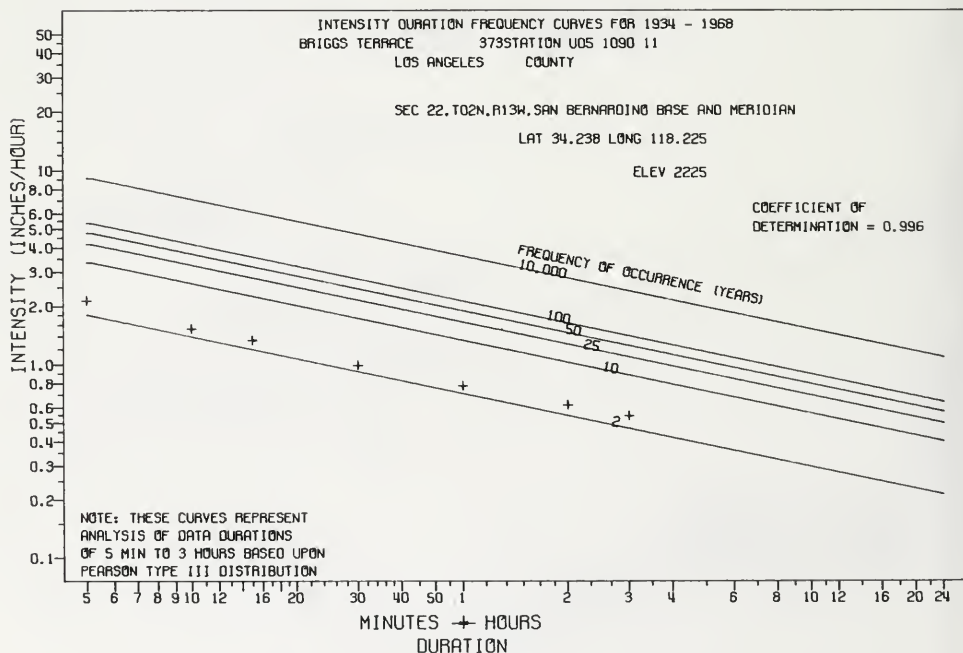
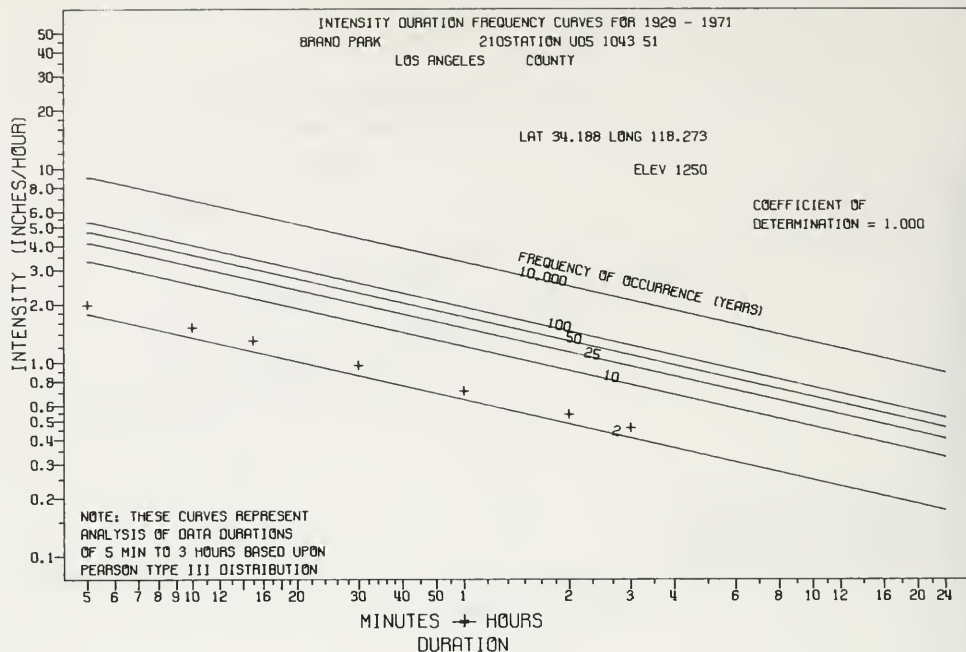












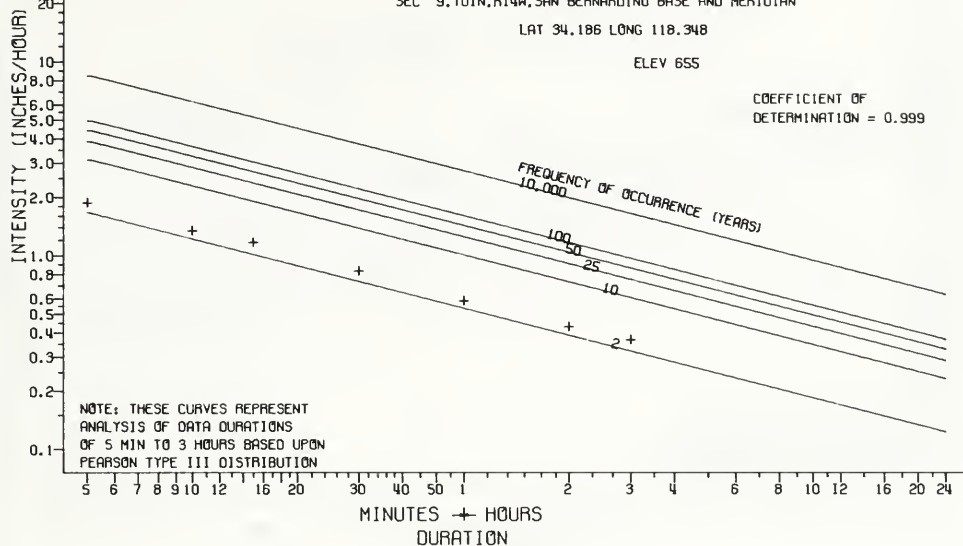
INTENSITY DURATION FREQUENCY CURVES FOR 1940 - 1974  
BURBANK VALLEY PUMP STATION UDS 1194 0  
LOS ANGELES COUNTY

SEC 9, T01N, R14W, SAN BERNARDINO BASE AND MERIDIAN

LAT 34.186 LONG 118.348

ELEV 655

COEFFICIENT OF  
DETERMINATION = 0.999



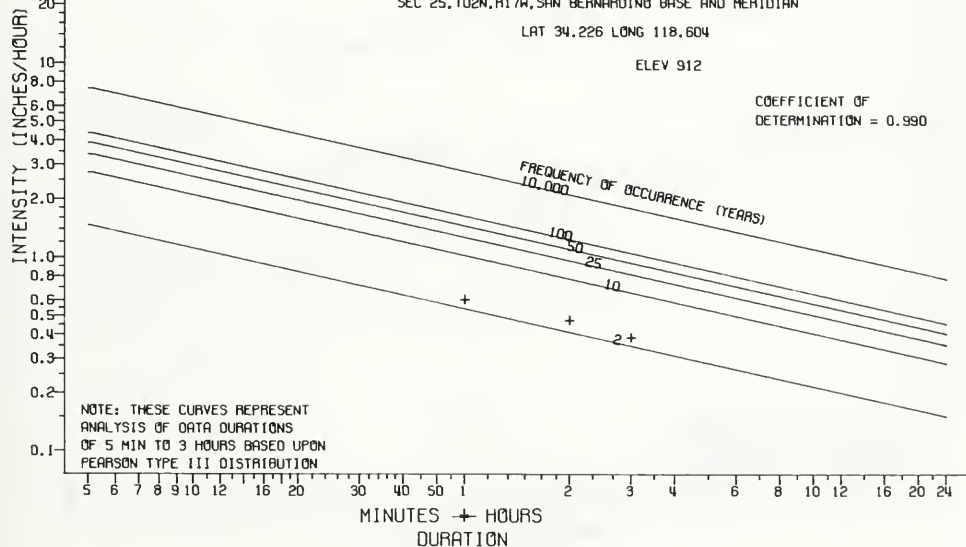
INTENSITY DURATION FREQUENCY CURVES FOR 1946 - 1974  
CHARTSWORTH RESERVOIR 23 STATION UDS 1682 0  
LOS ANGELES COUNTY

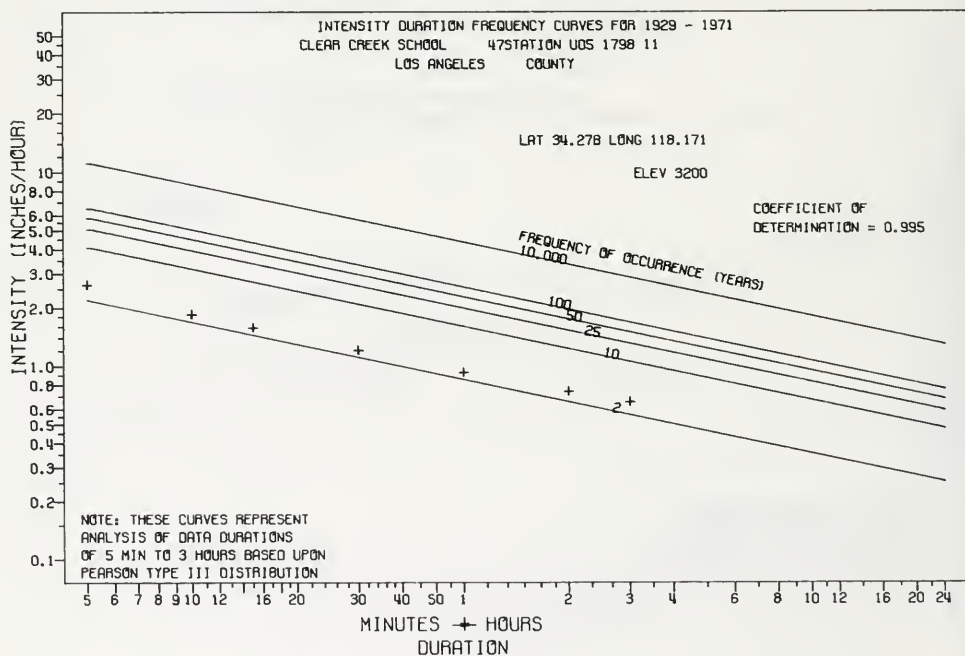
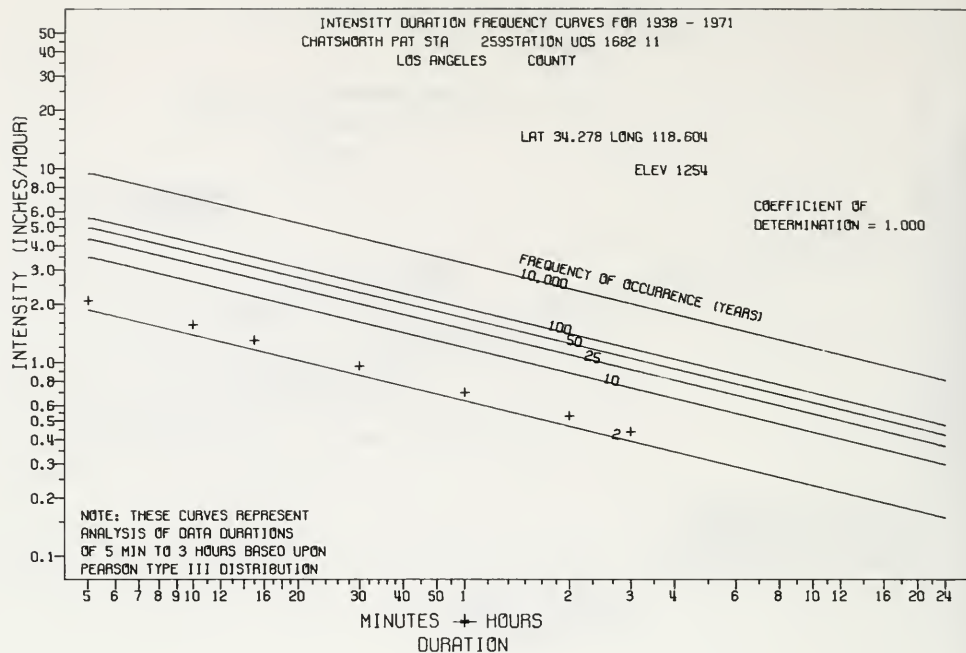
SEC 25, T02N, R17W, SAN BERNARDINO BASE AND MERIDIAN

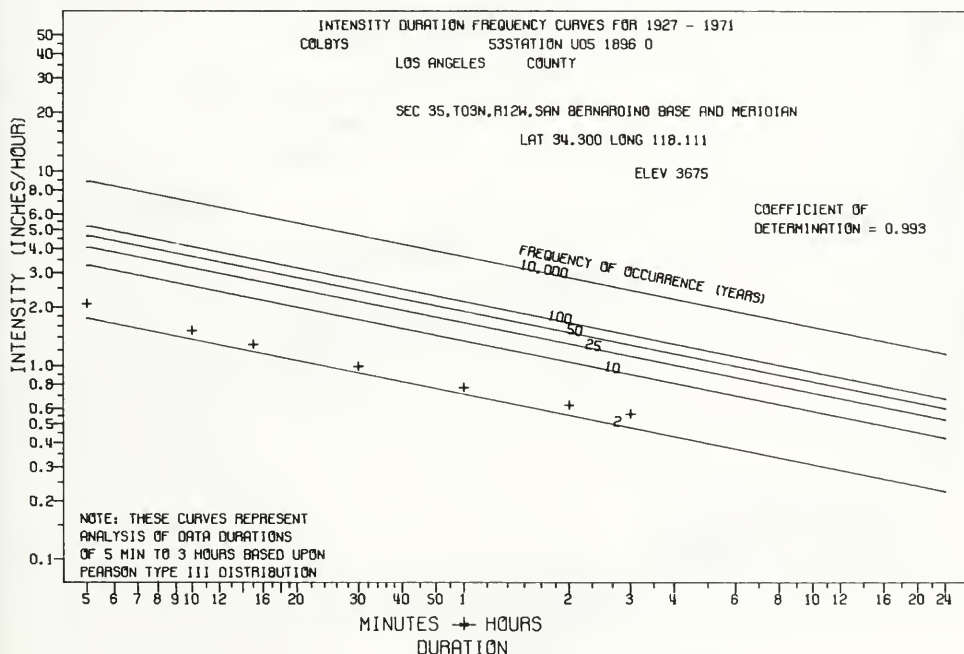
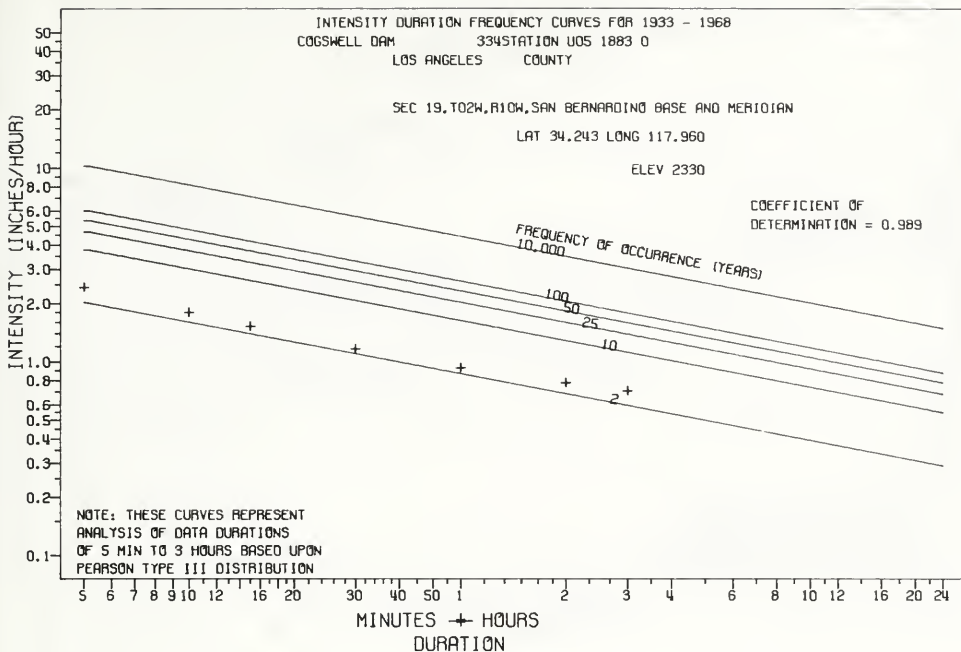
LAT 34.226 LONG 118.604

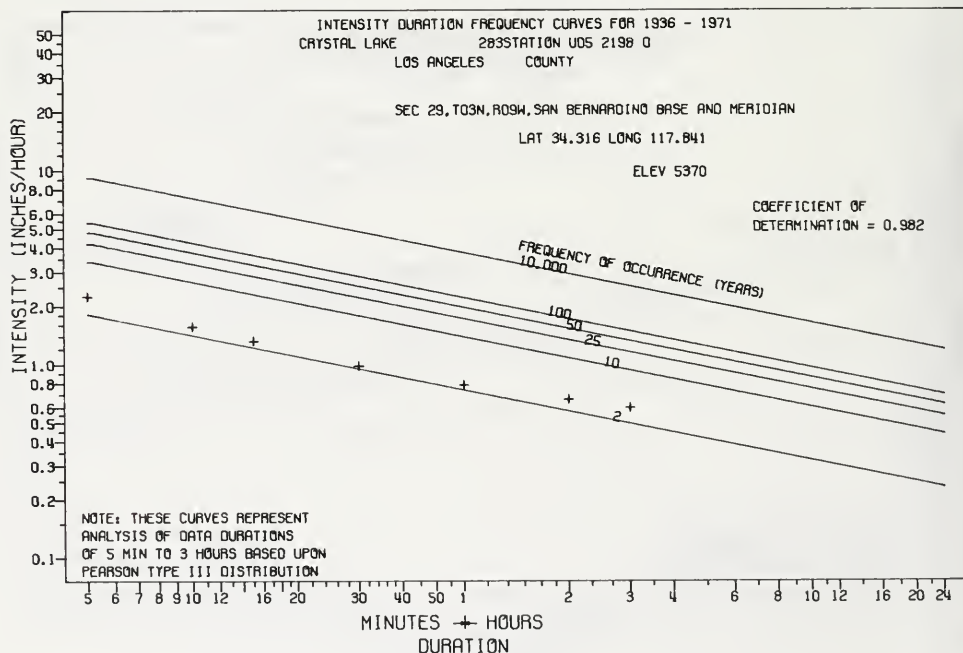
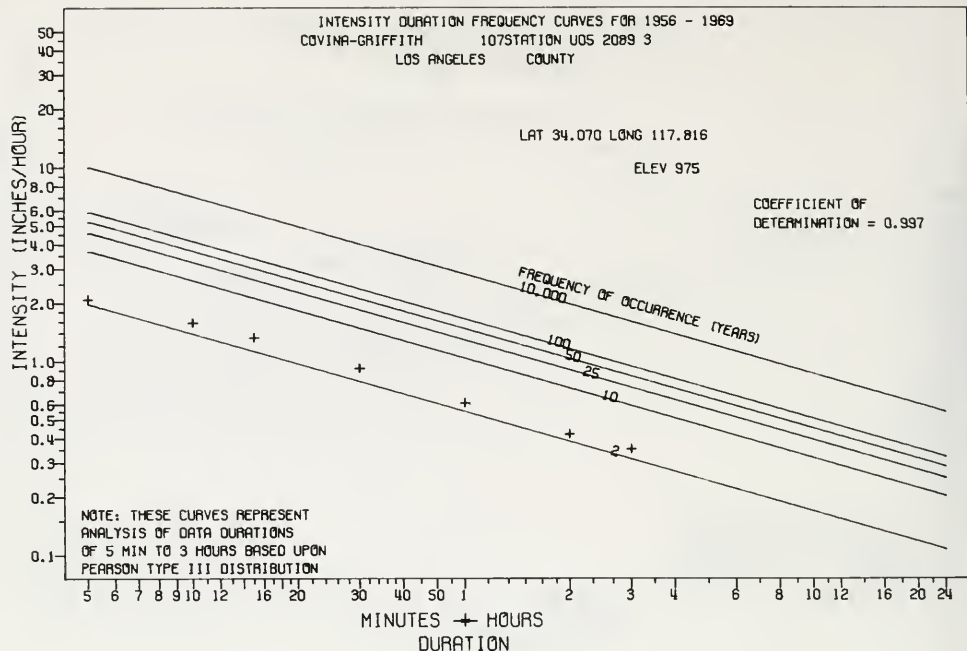
ELEV 912

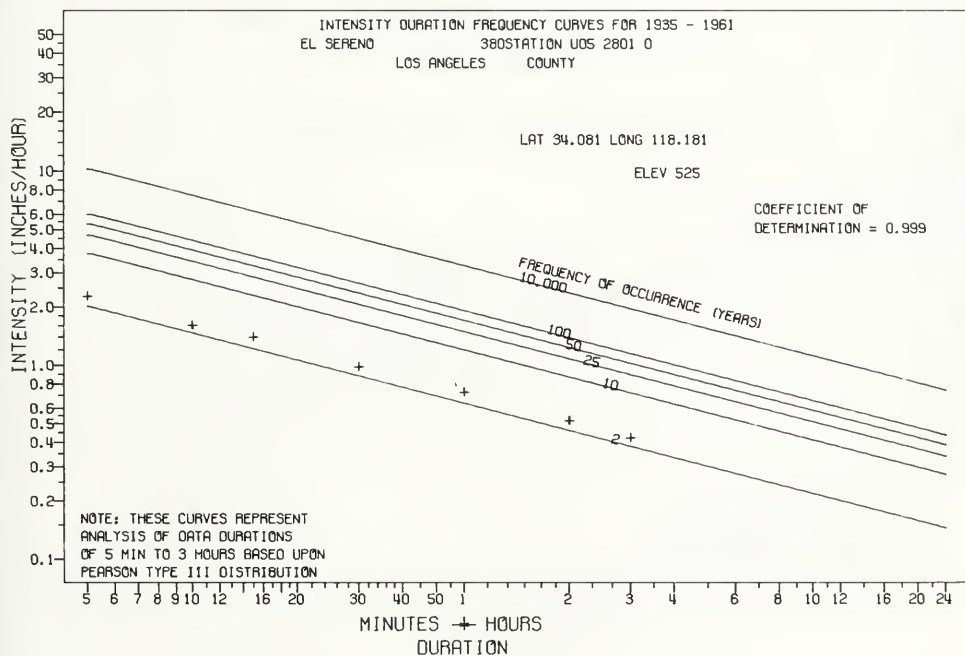
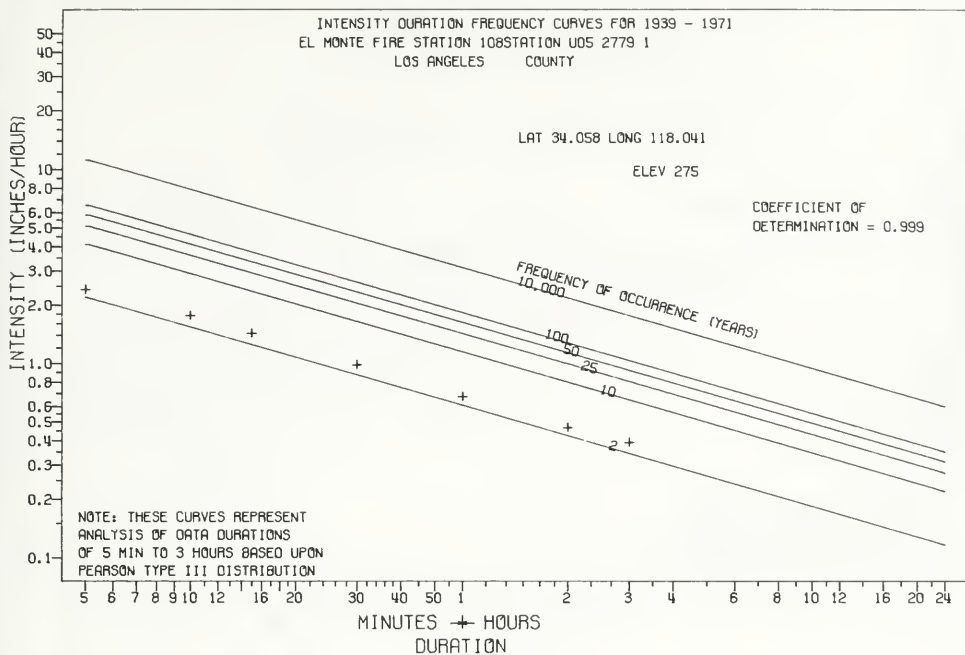
COEFFICIENT OF  
DETERMINATION = 0.990



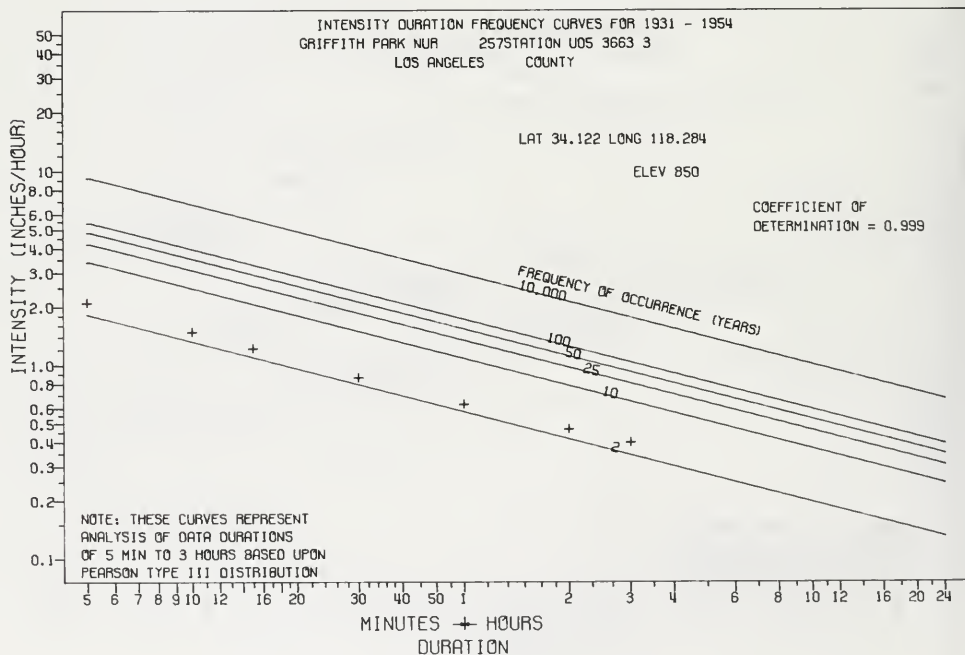
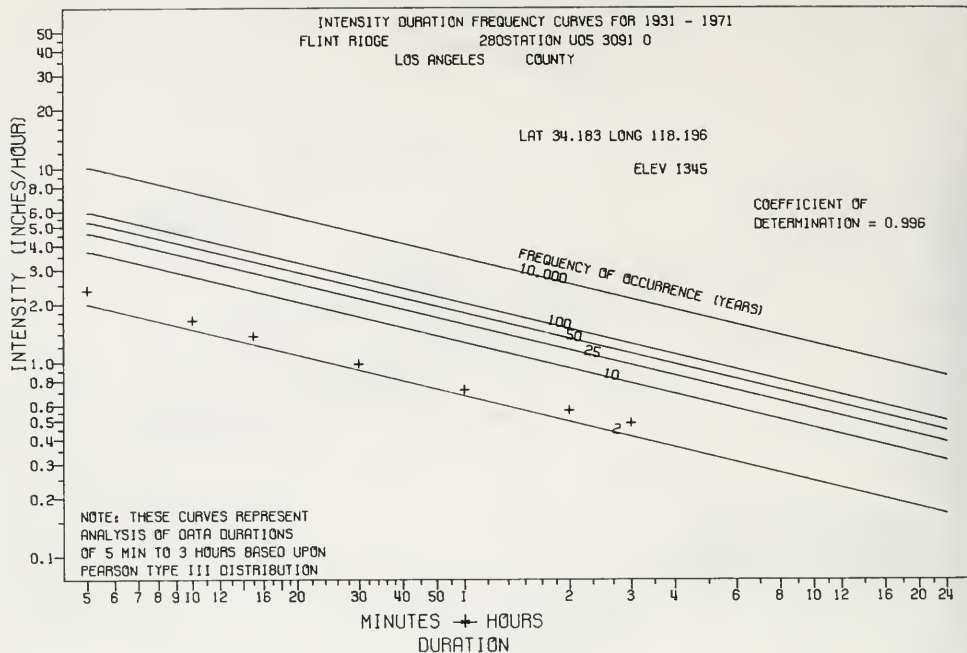




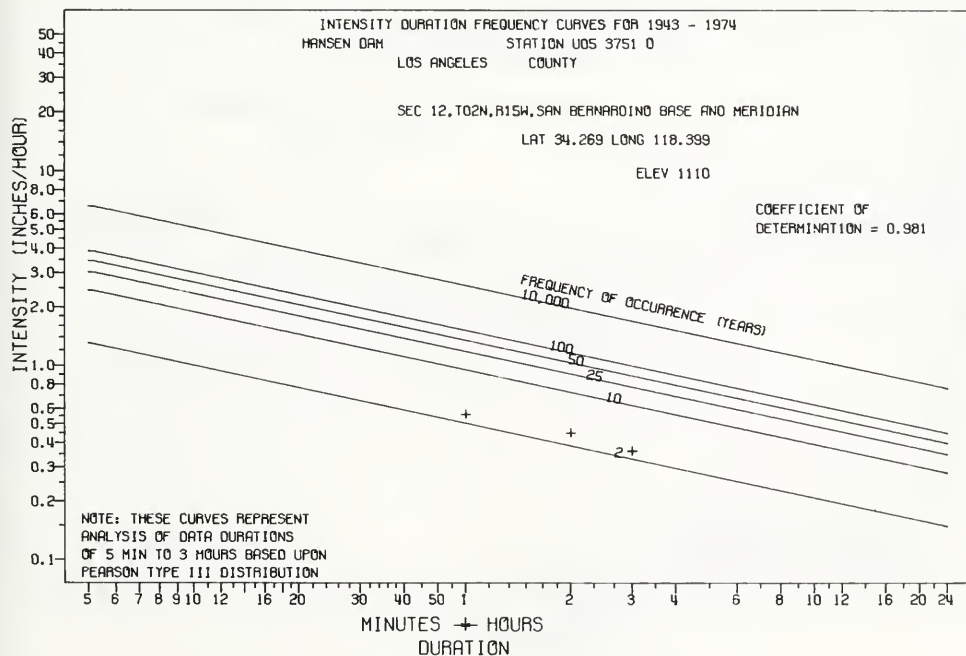
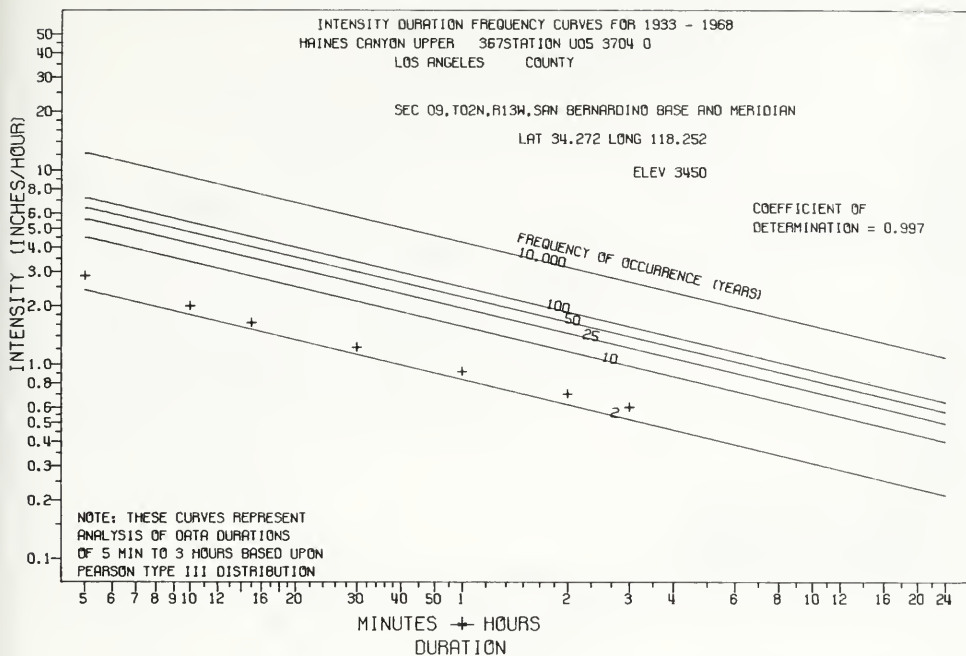


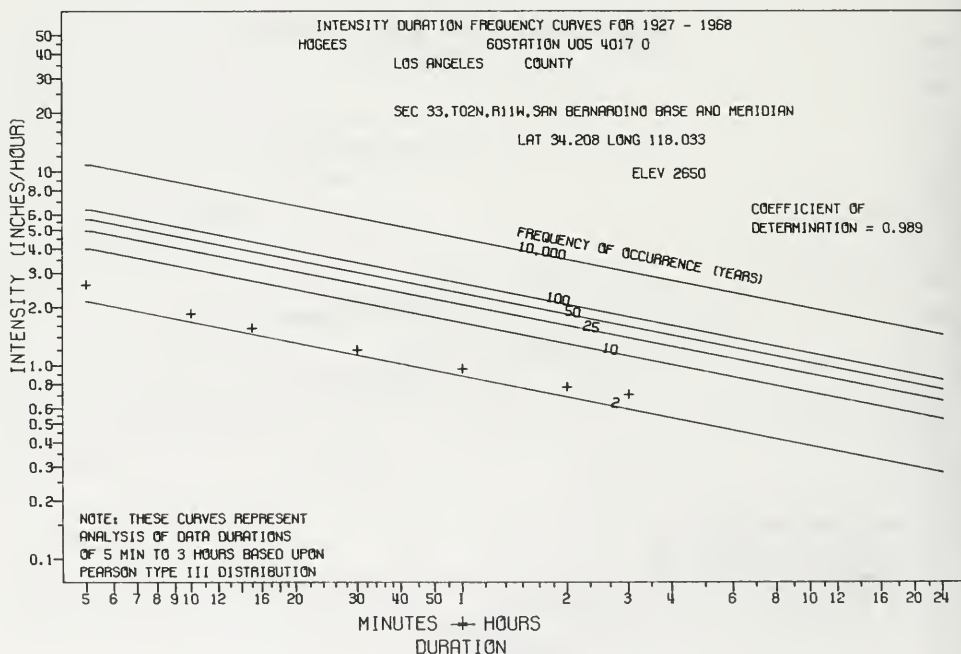
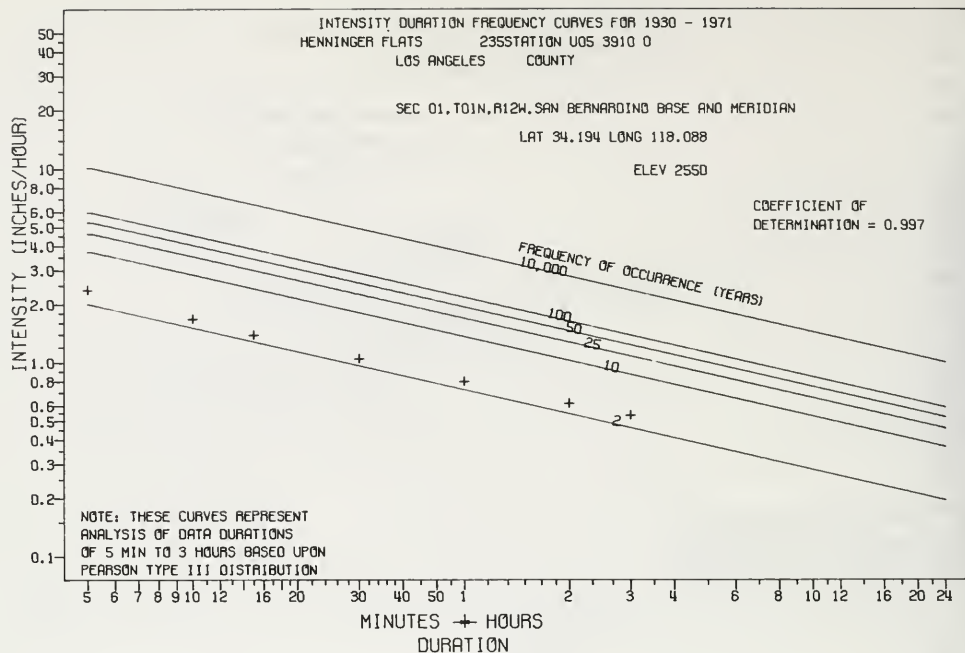


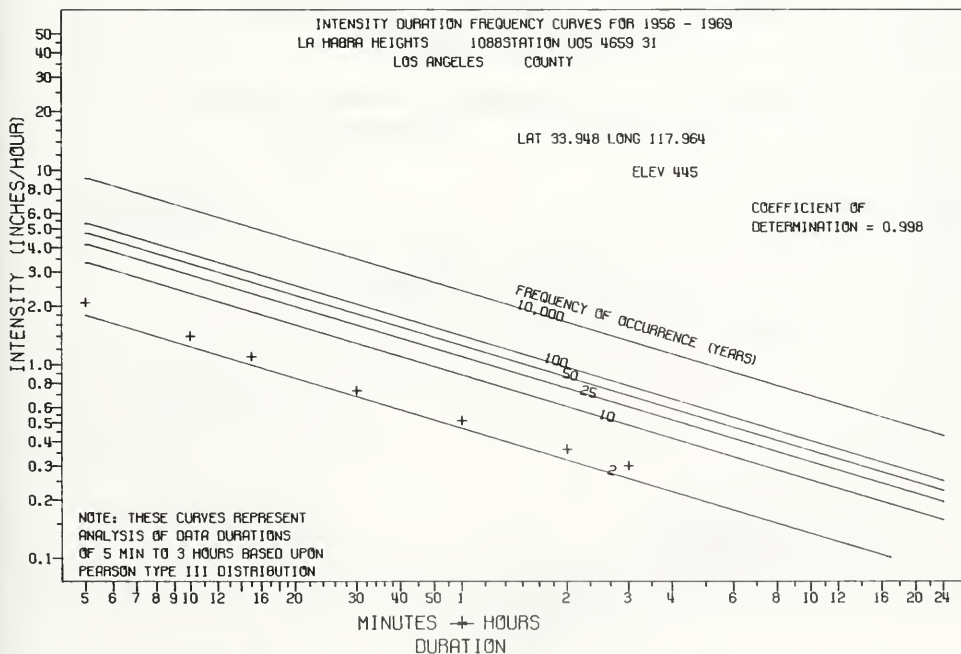
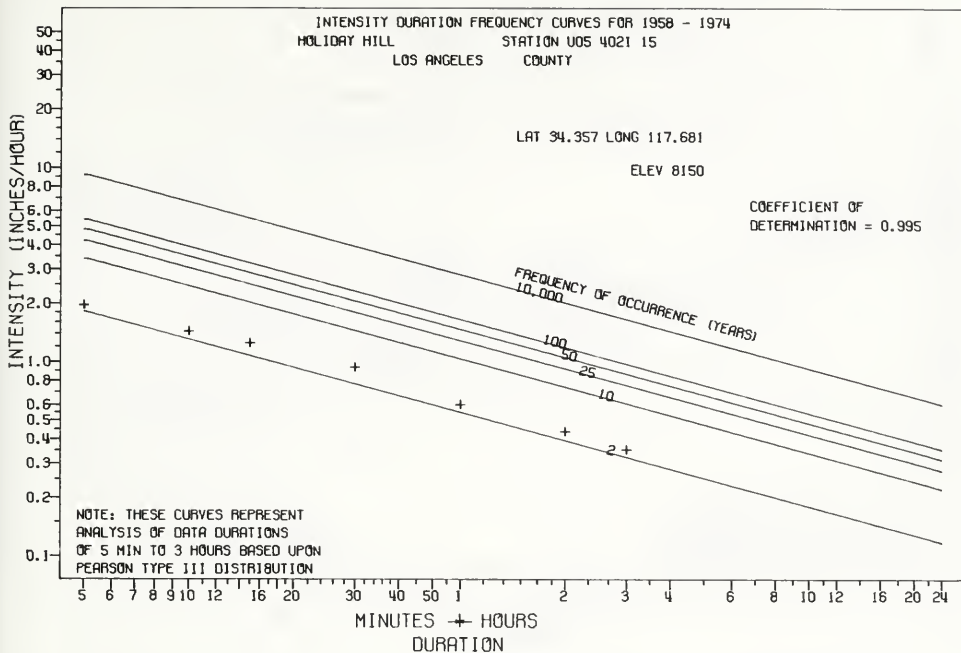


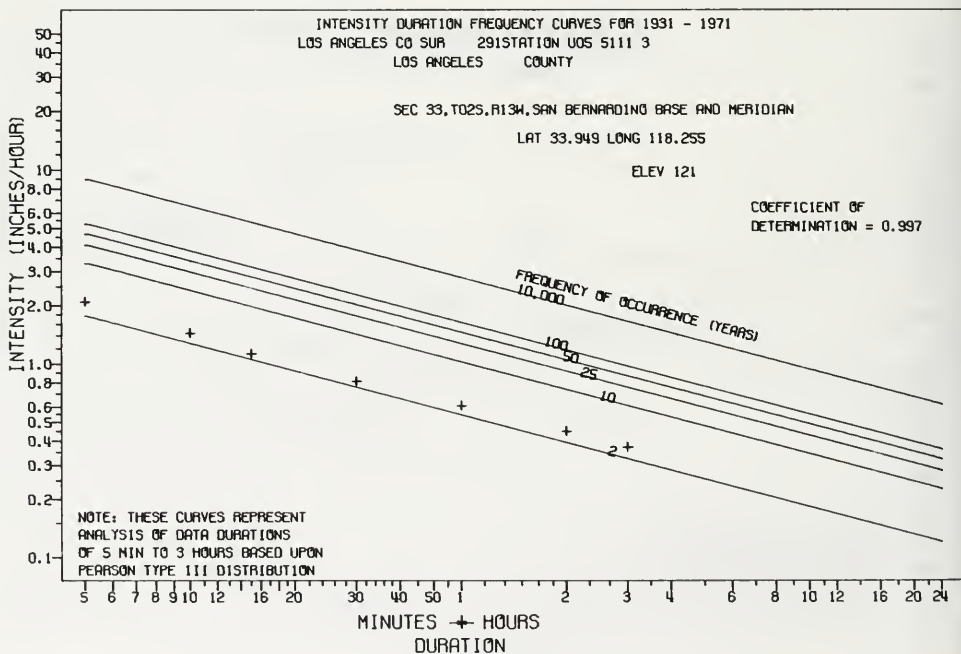
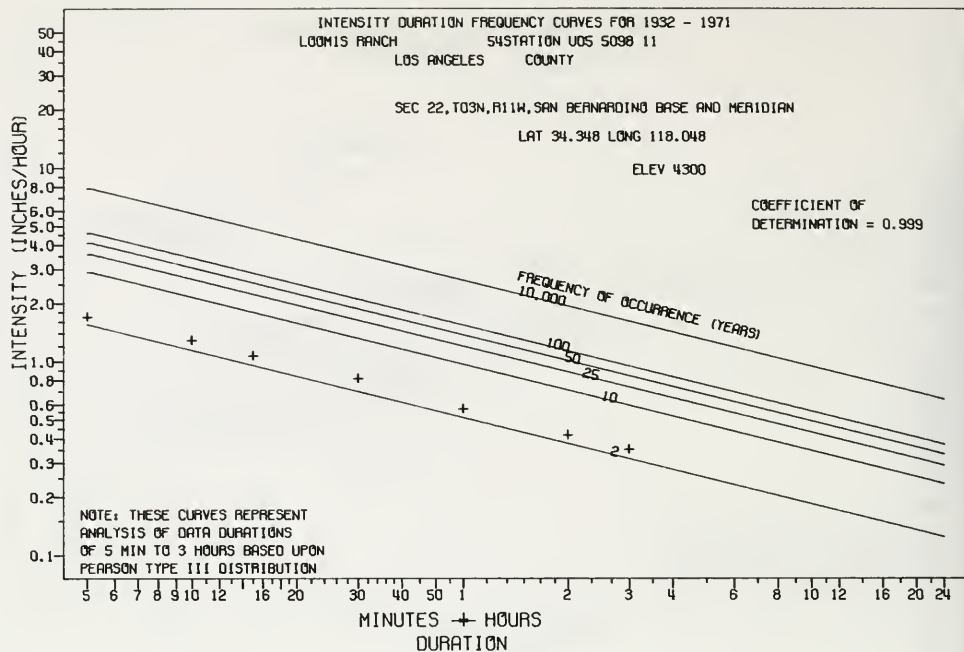


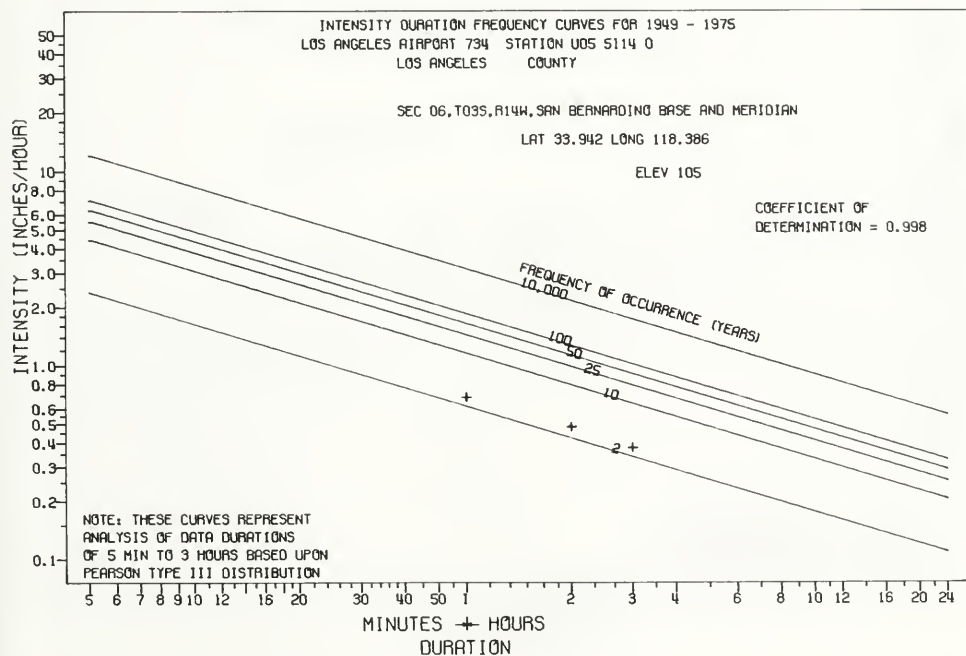
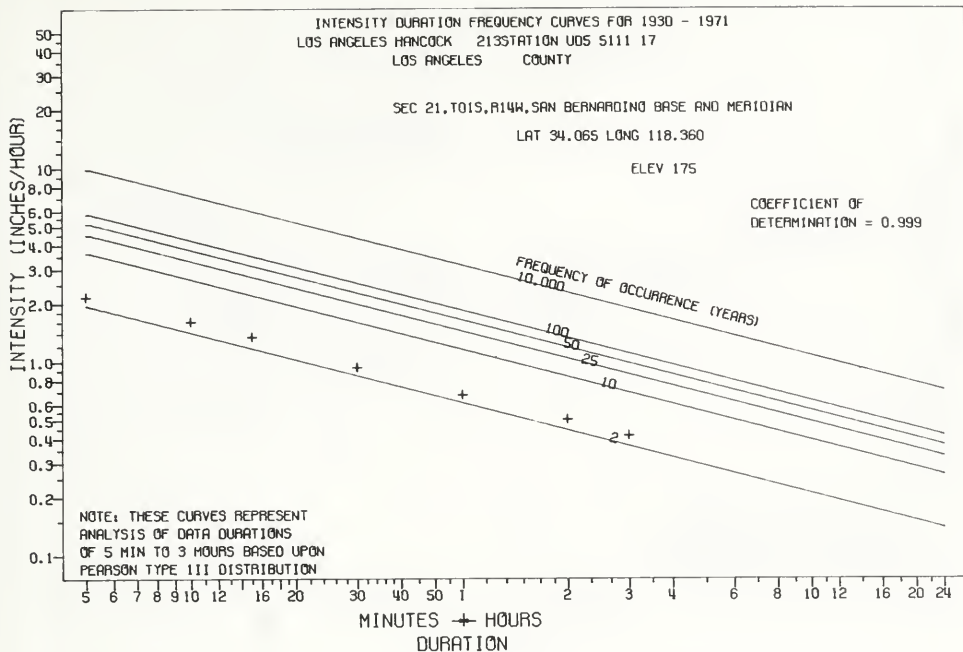


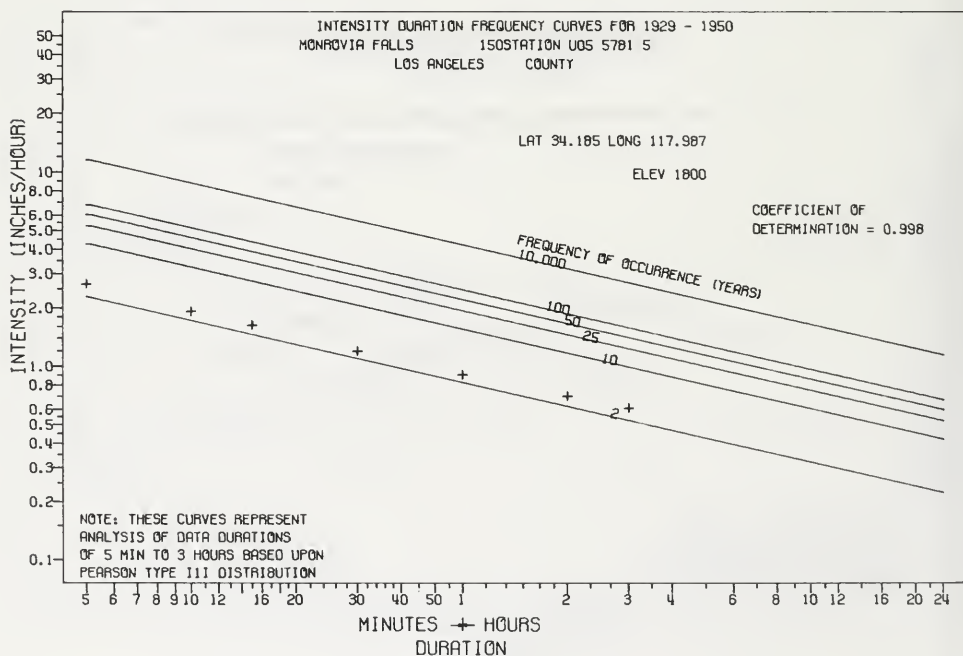
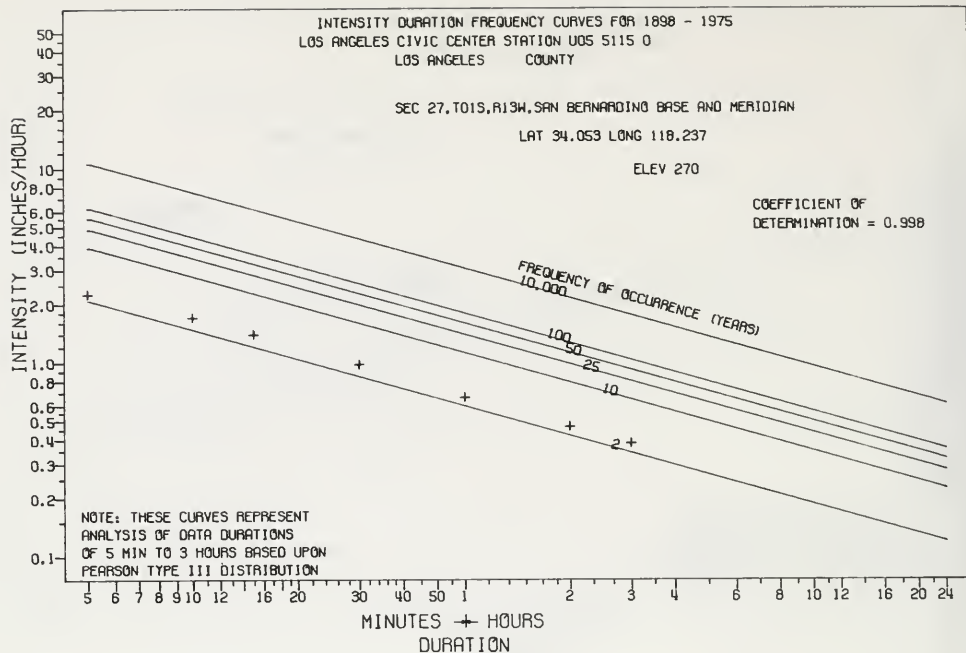


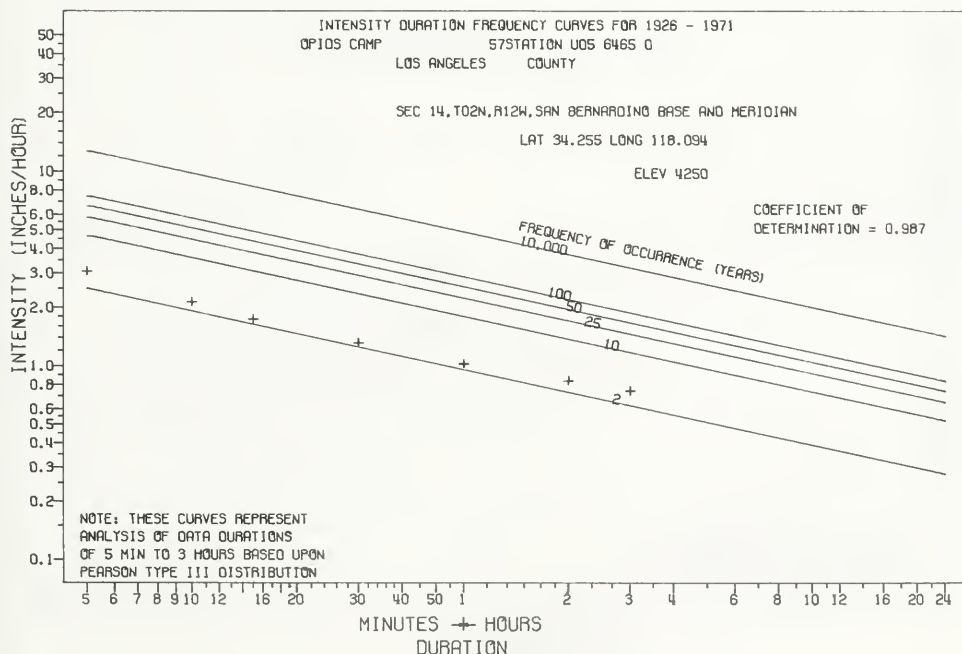
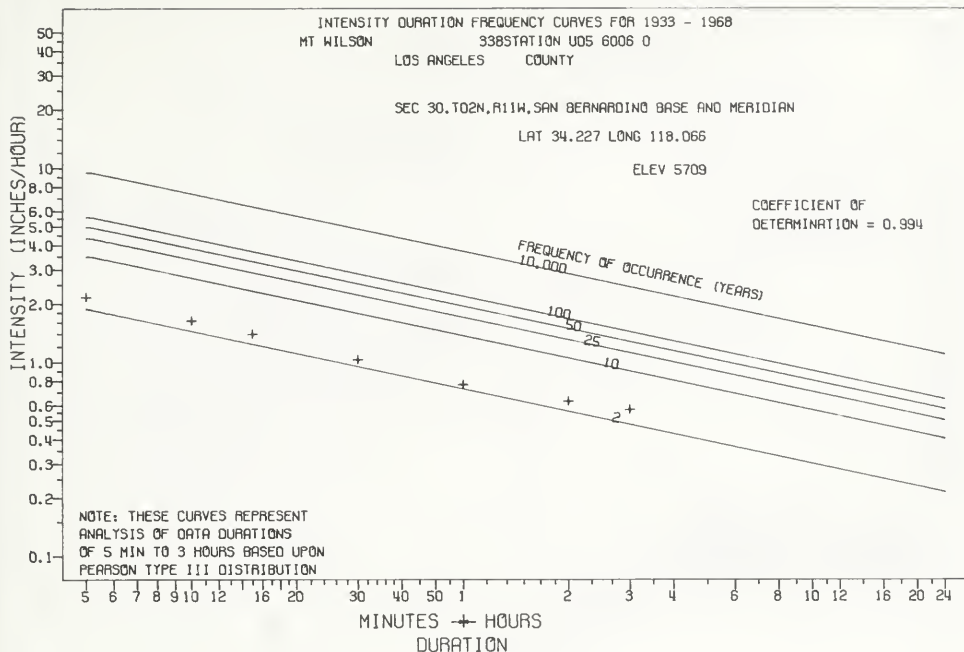




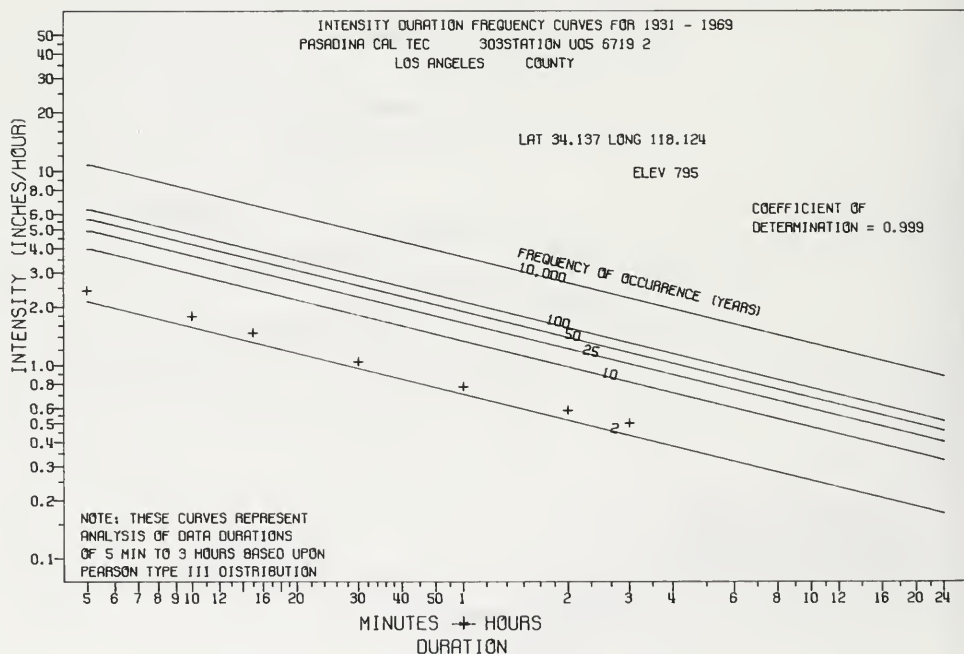
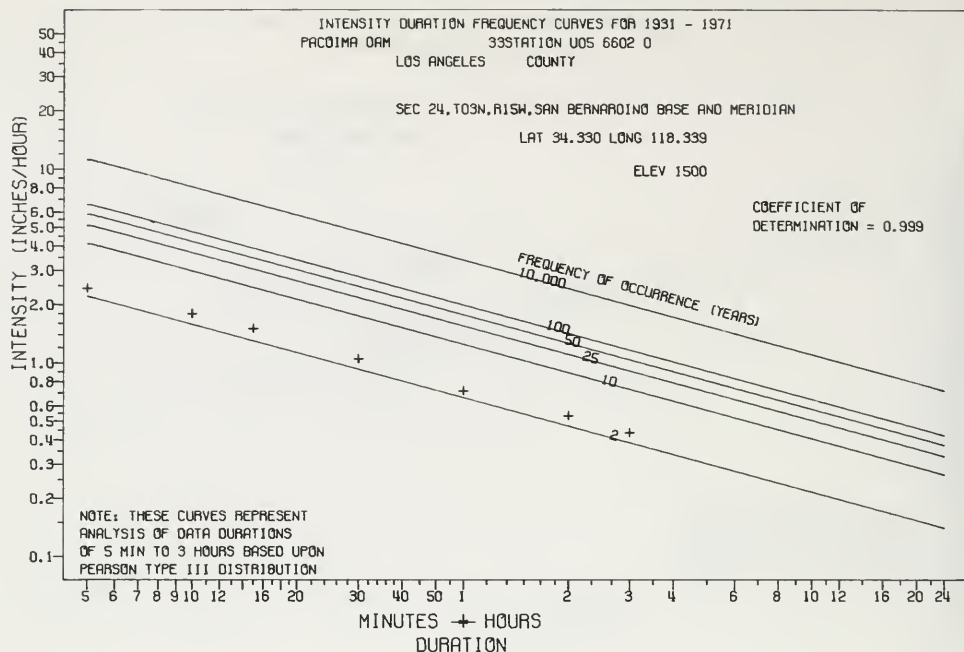














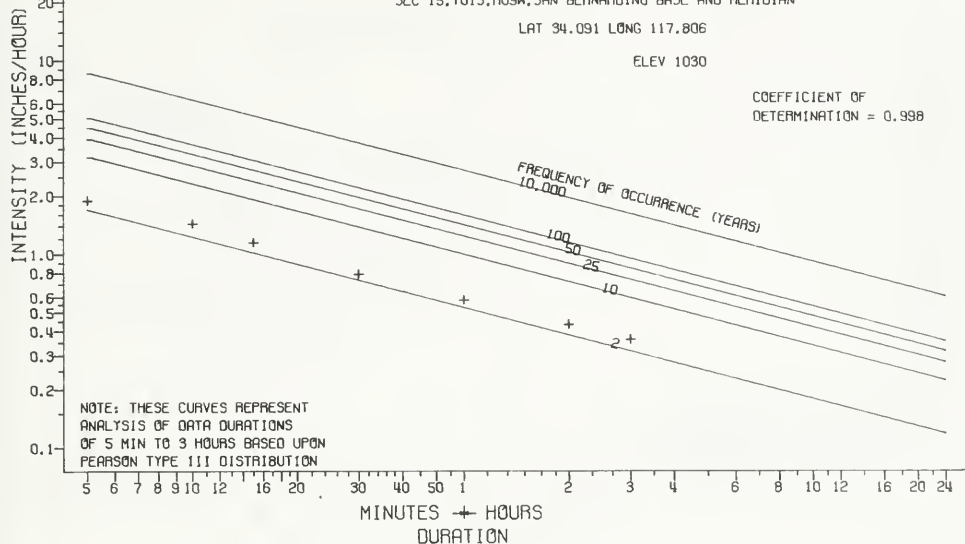
INTENSITY DURATION FREQUENCY CURVES FOR 1953 - 1971  
PUDDINGSTONE DAM STATION U05 7160 1  
LOS ANGELES COUNTY

SEC 15, T01S, R09W, SAN BERNARDINO BASE AND MERIDIAN

LAT 34.091 LONG 117.806

ELEV 1030

COEFFICIENT OF  
DETERMINATION = 0.998

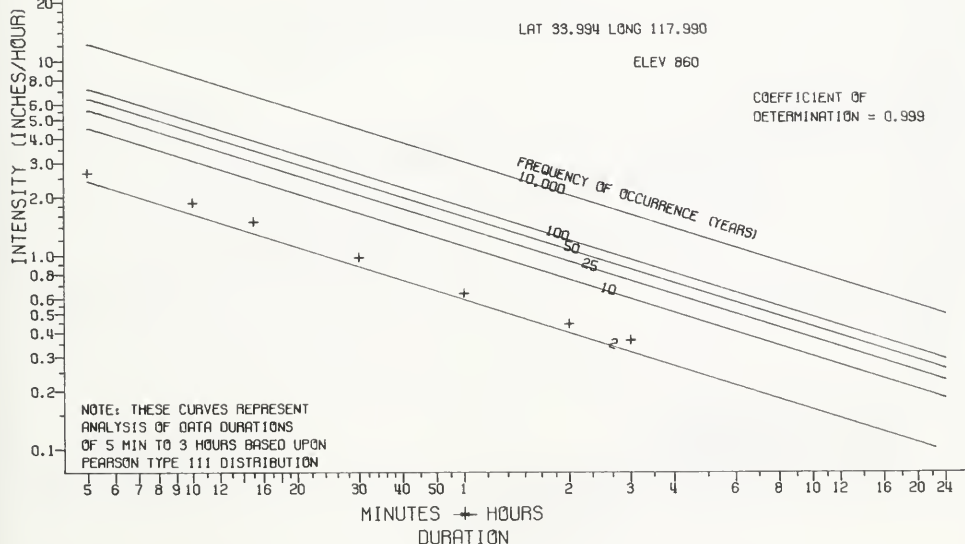


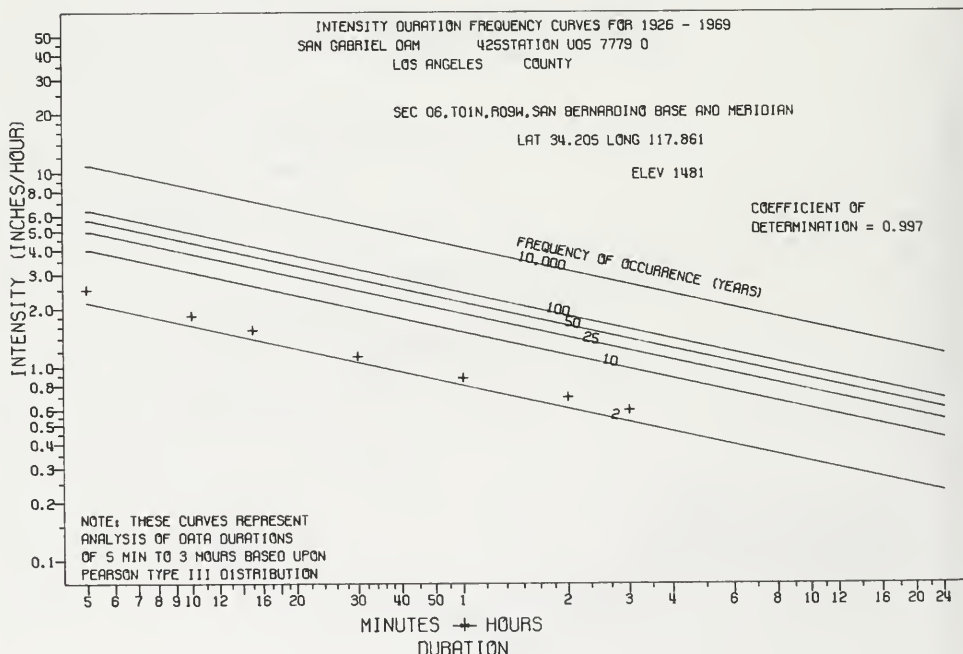
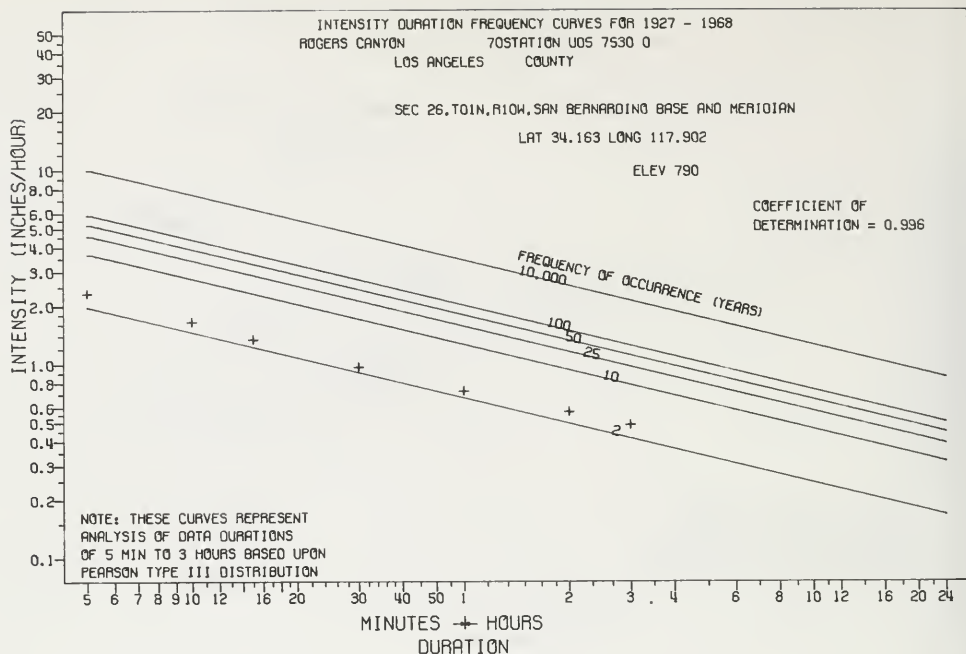
INTENSITY DURATION FREQUENCY CURVES FOR 1941 - 1972  
PUENTE HILLS STATION U05 7161 6  
LOS ANGELES COUNTY

LAT 33.994 LONG 117.990

ELEV 860

COEFFICIENT OF  
DETERMINATION = 0.999





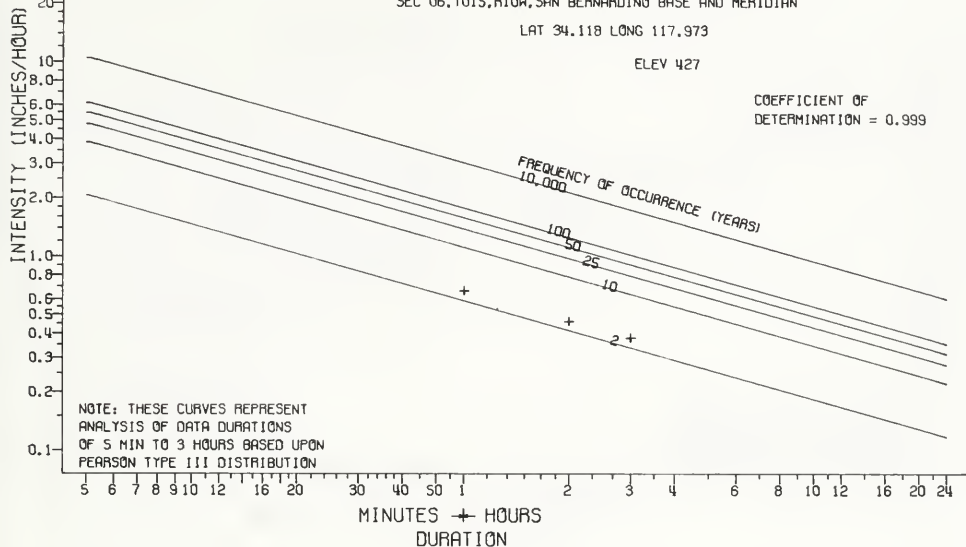
INTENSITY DURATION FREQUENCY CURVES FOR 1946 - 1974  
 SANTE FE DAM STATION U05 7926 0  
 LOS ANGELES COUNTY

SEC 06, T01S, R10W, SAN BERNARDINO BASE AND MERIDIAN

LAT 34.118 LONG 117.973

ELEV 427

COEFFICIENT OF  
 DETERMINATION = 0.999



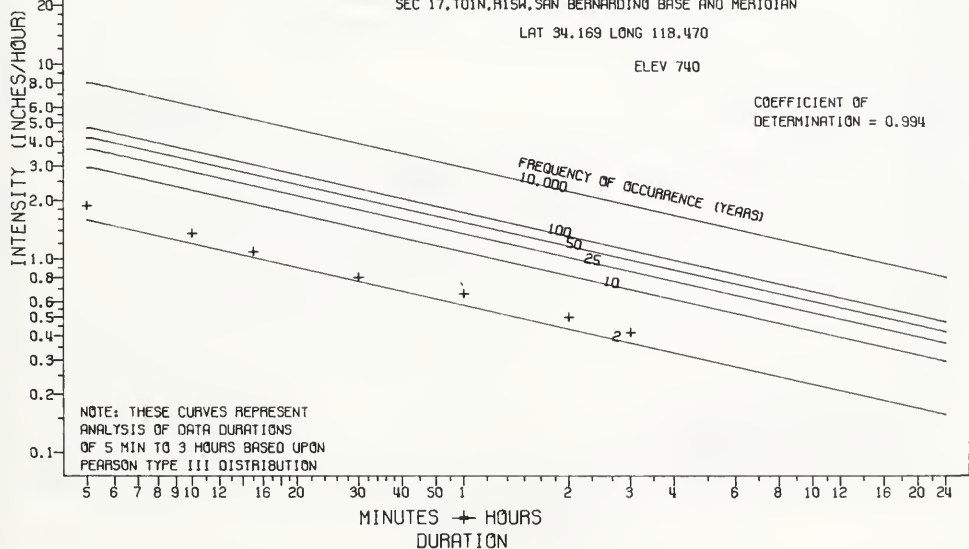
INTENSITY DURATION FREQUENCY CURVES FOR 1946 - 1974  
 SEPULVEDA DAM 465 STATION U05 8092 0  
 LOS ANGELES COUNTY

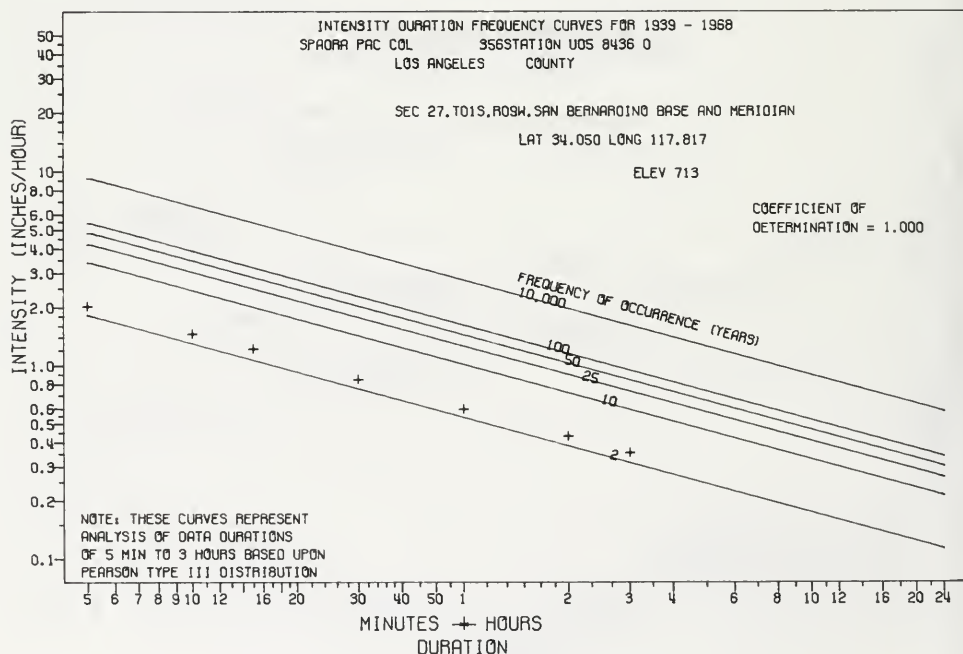
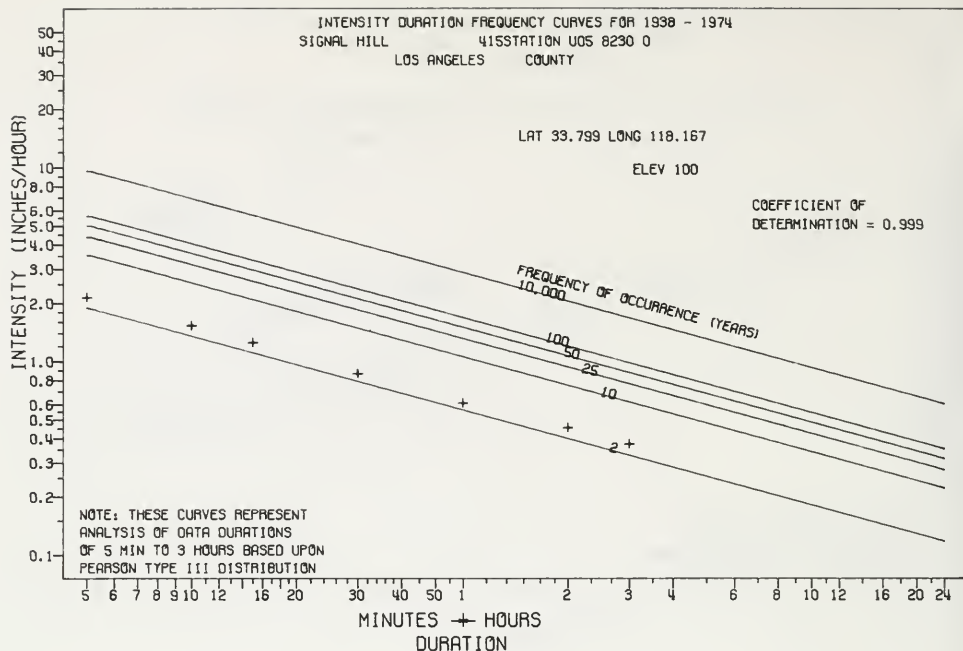
SEC 17, T01N, R15W, SAN BERNARDINO BASE AND MERIDIAN

LAT 34.169 LONG 118.470

ELEV 740

COEFFICIENT OF  
 DETERMINATION = 0.994



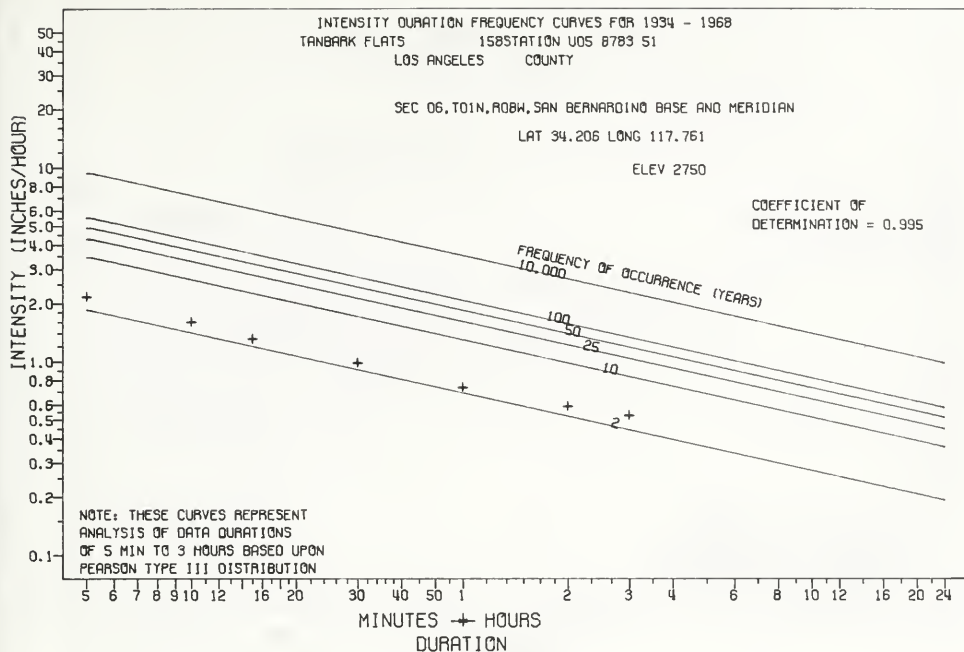


INTENSITY DURATION FREQUENCY CURVES FOR 1934 - 1968  
TANBAK FLATS 158 STATION UDS 8783 51  
LOS ANGELES COUNTY

SEC 06, T01N, R08W, SAN BERNARDINO BASE AND MERIDIAN  
LAT 34.206 LONG 117.761

ELEV 2750

COEFFICIENT OF  
DETERMINATION = 0.995



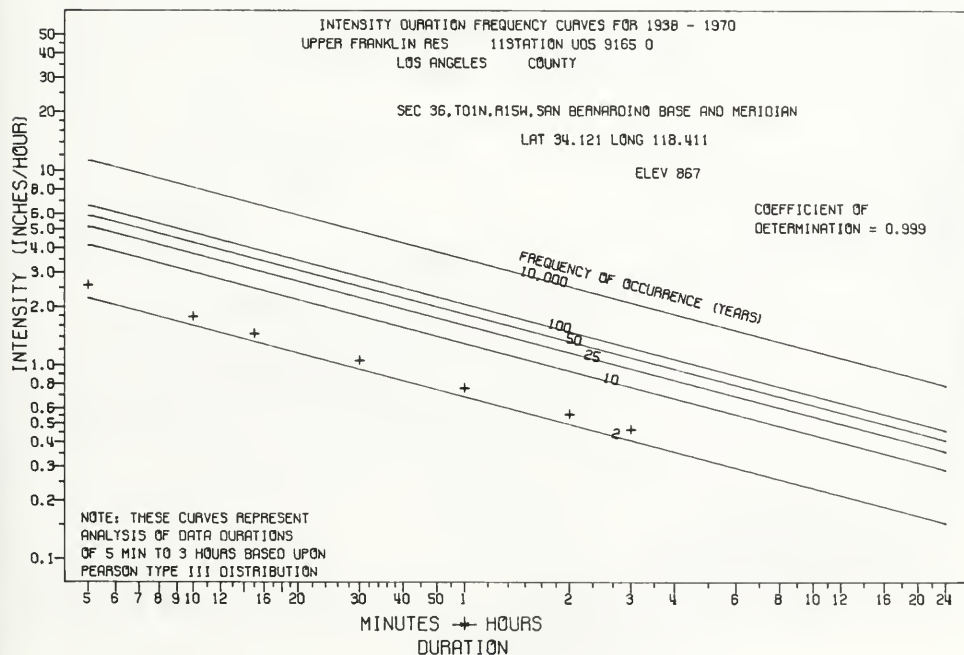
INTENSITY DURATION FREQUENCY CURVES FOR 1938 - 1970  
UPPER FRANKLIN RES 11 STATION UDS 9165 0  
LOS ANGELES COUNTY

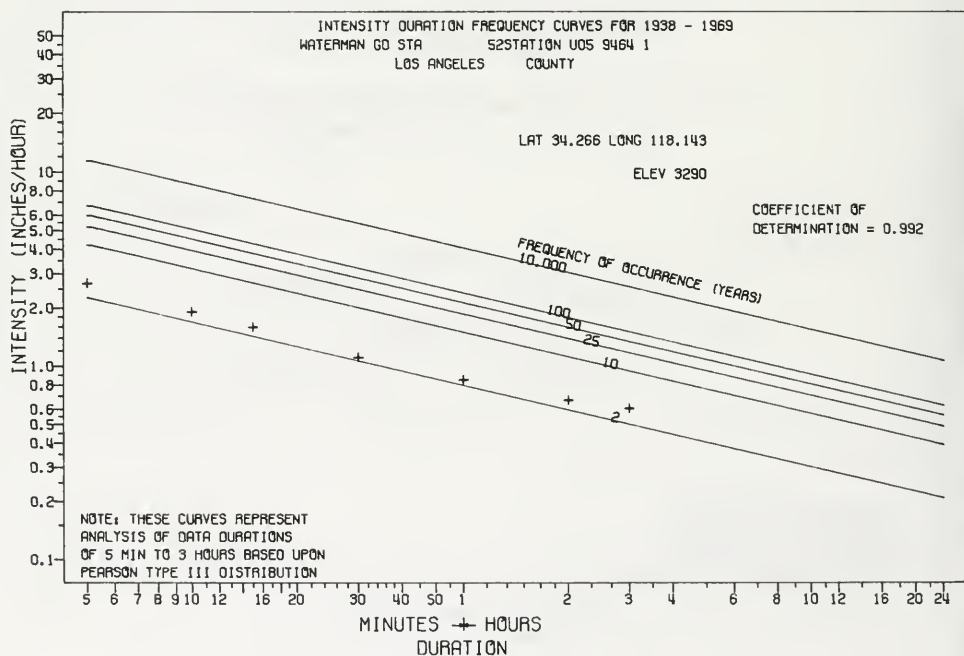
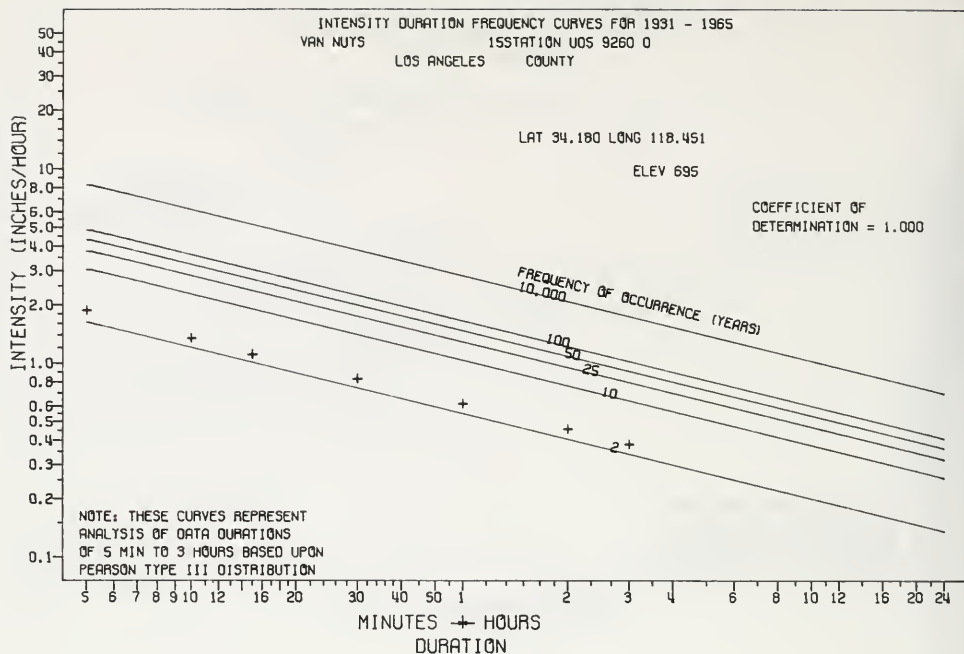
SEC 36, T01N, R15W, SAN BERNARDINO BASE AND MERIDIAN

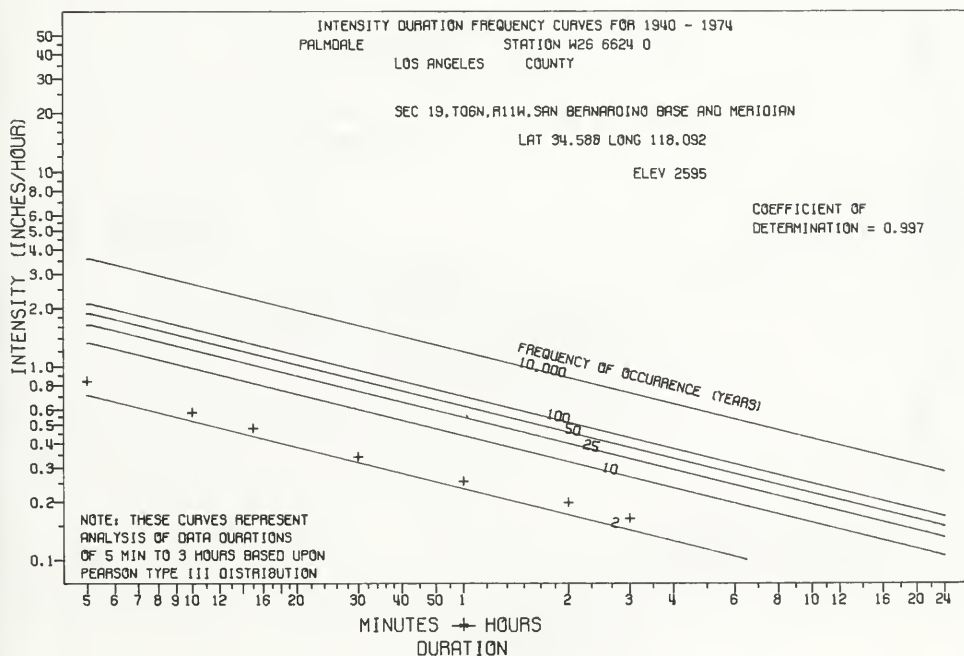
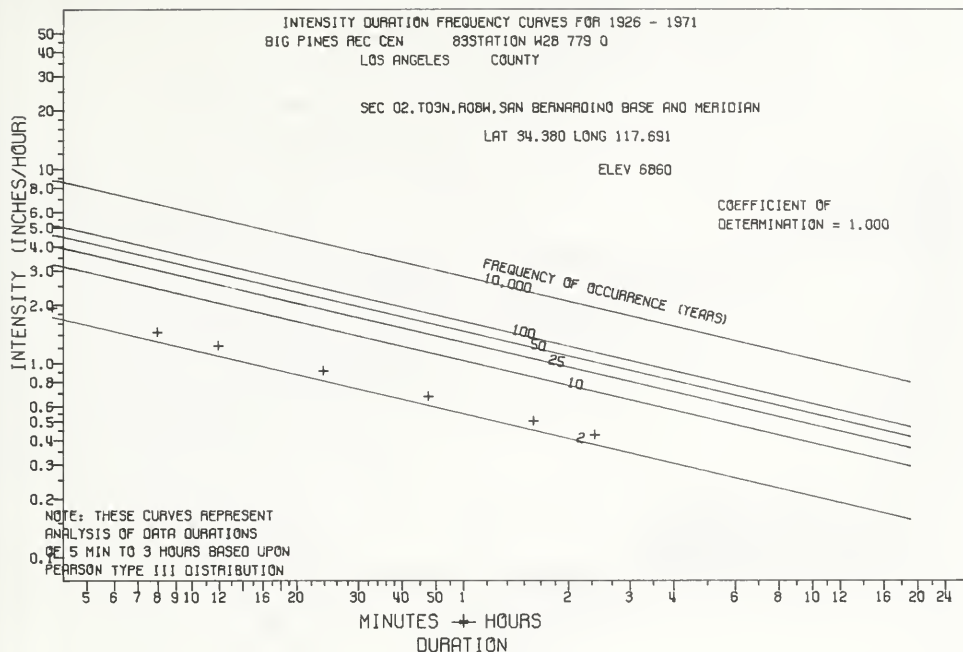
LAT 34.121 LONG 118.411

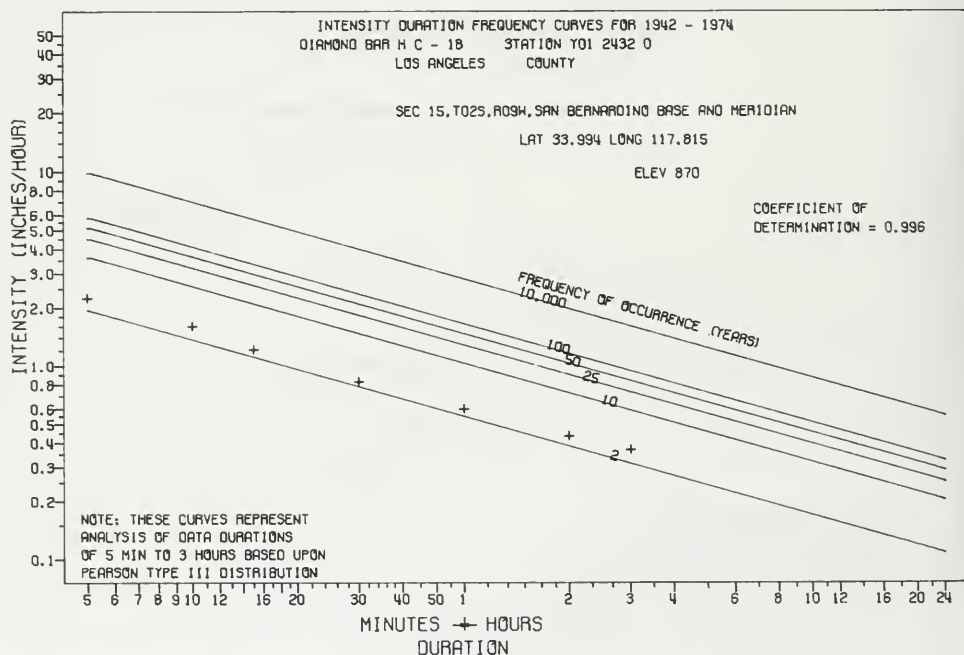
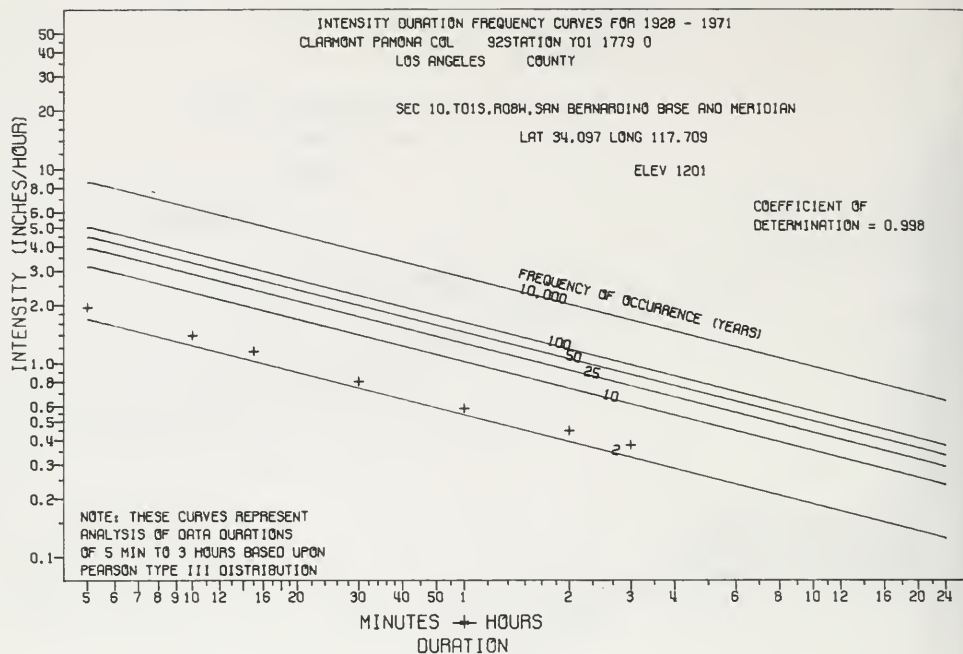
ELEV 867

COEFFICIENT OF  
DETERMINATION = 0.999

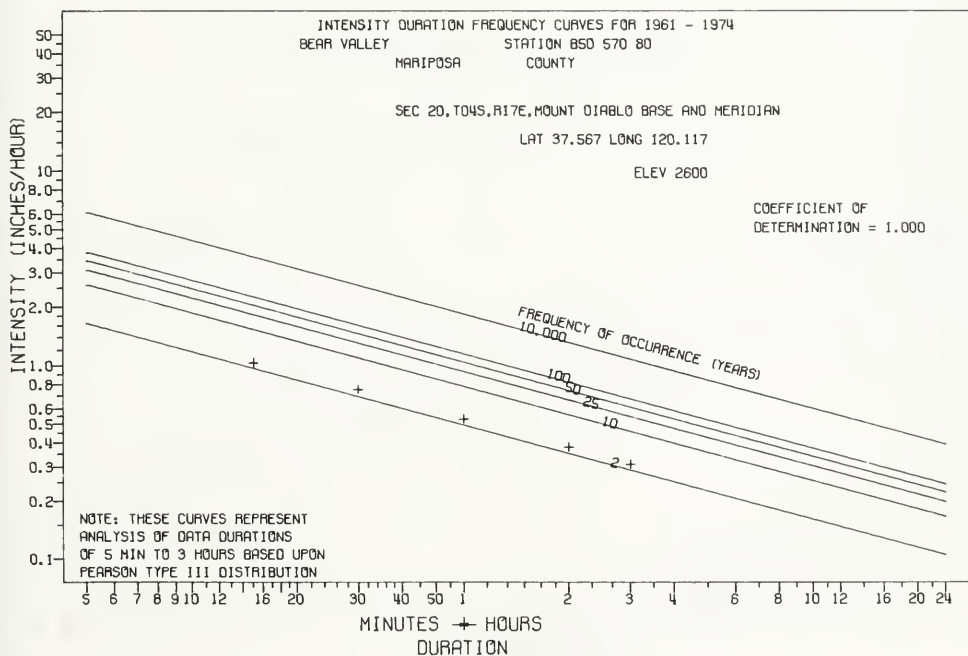
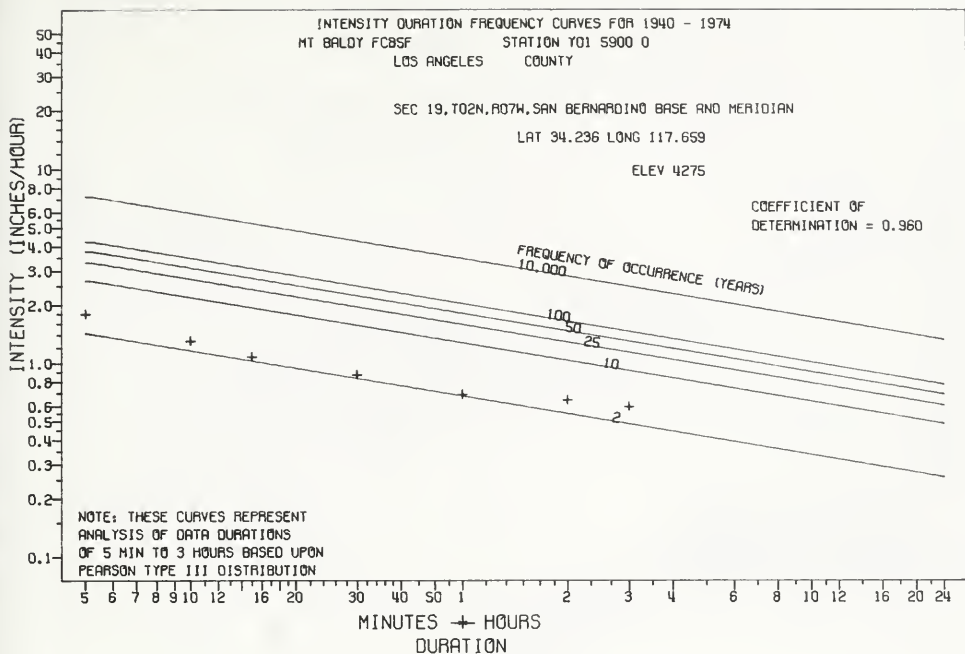


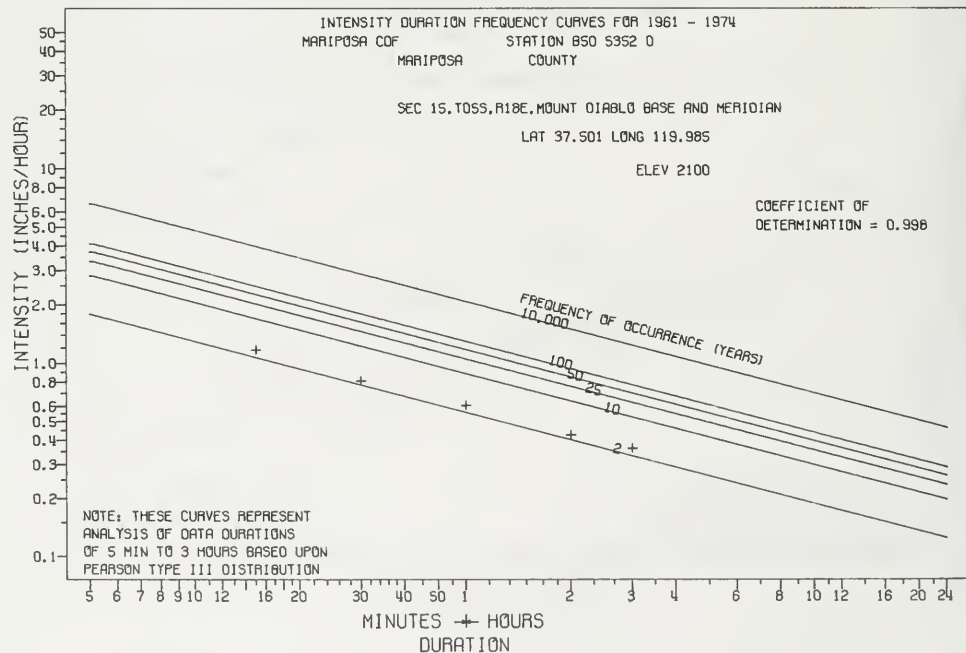
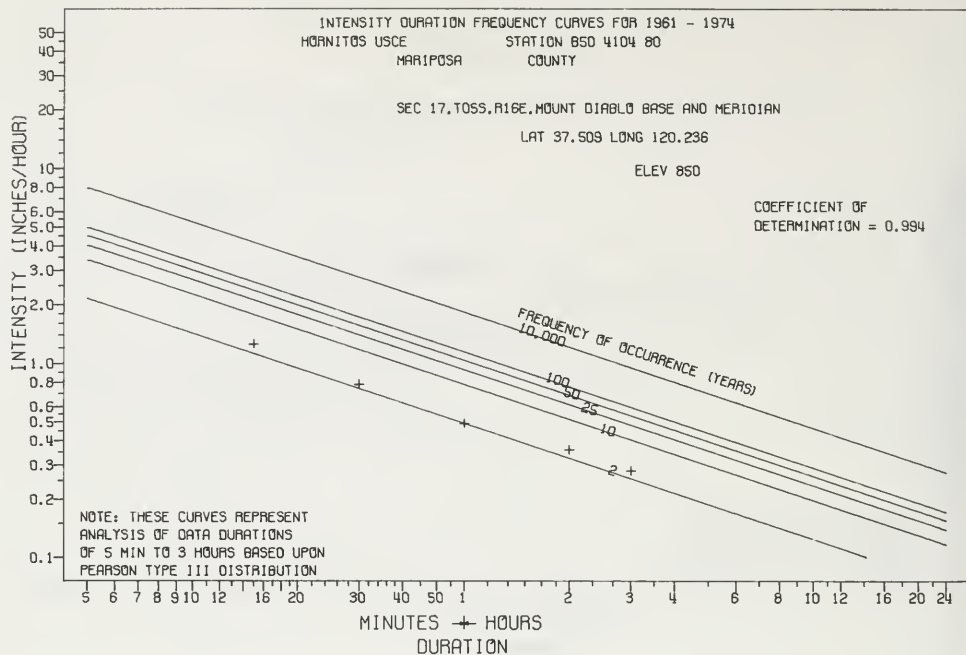


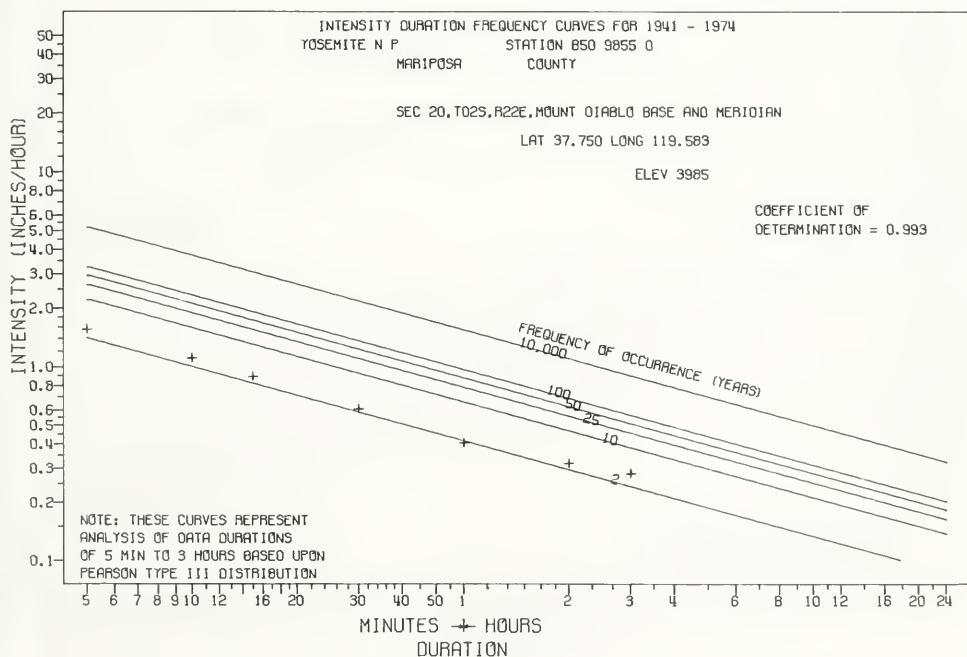
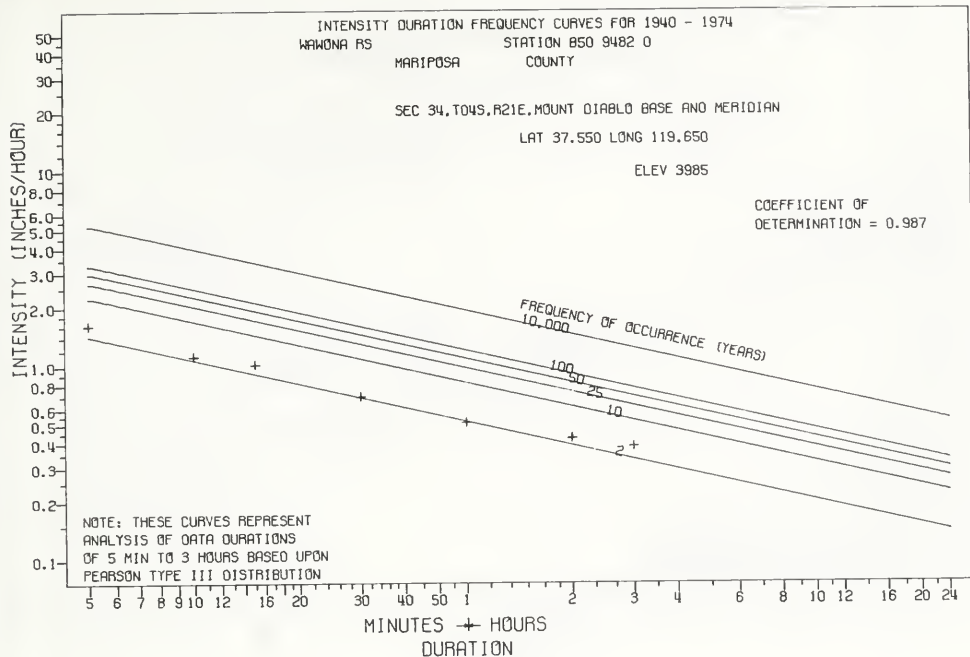


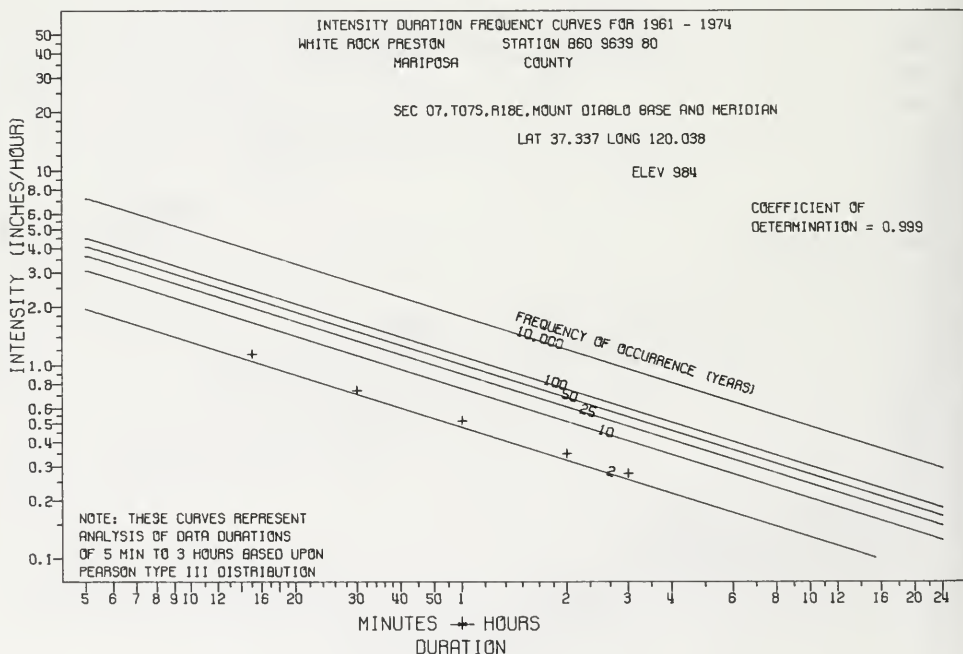
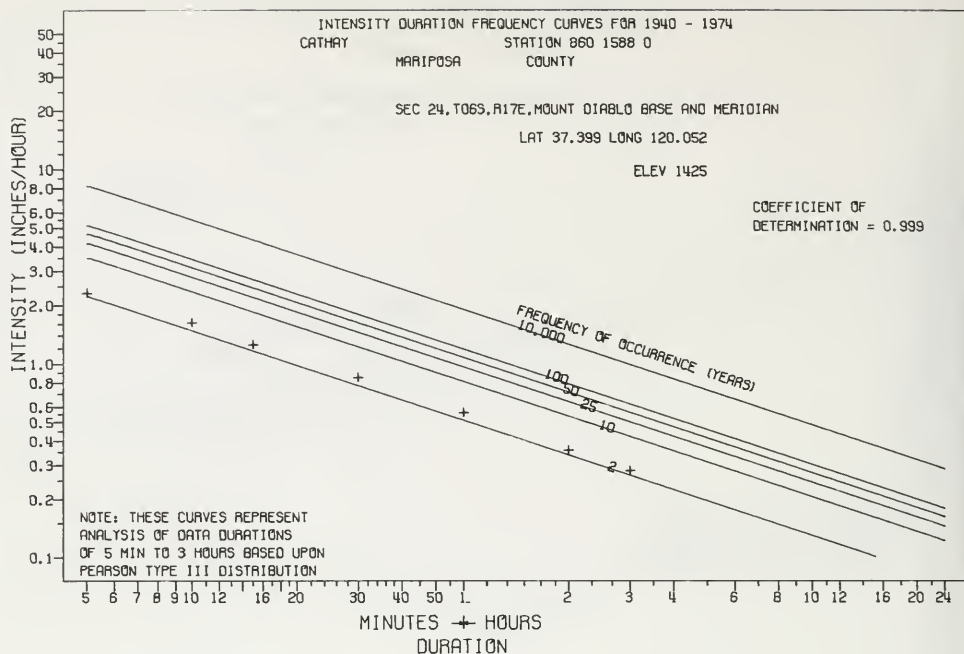


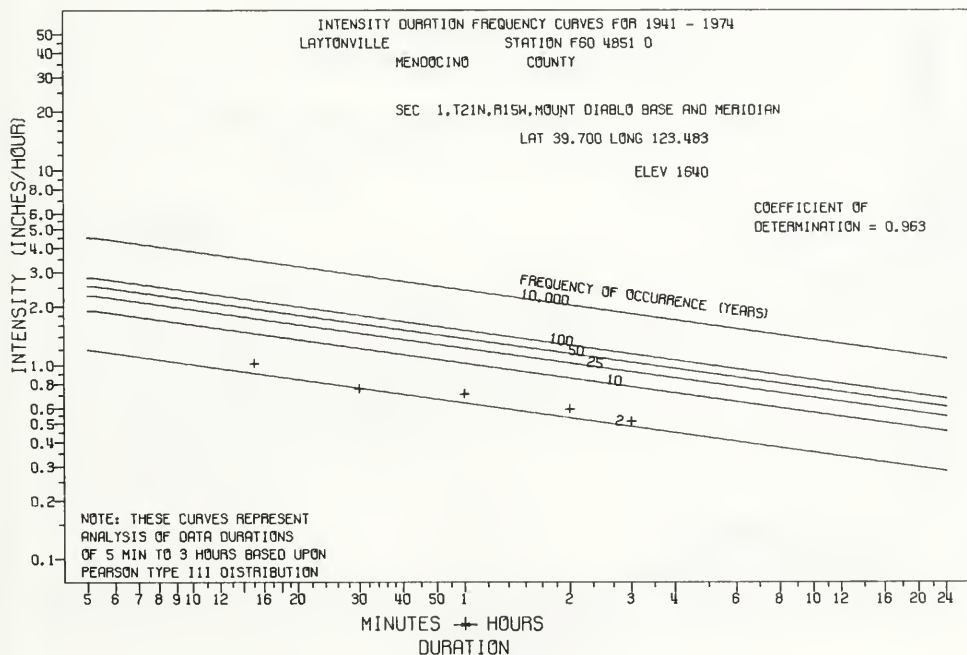
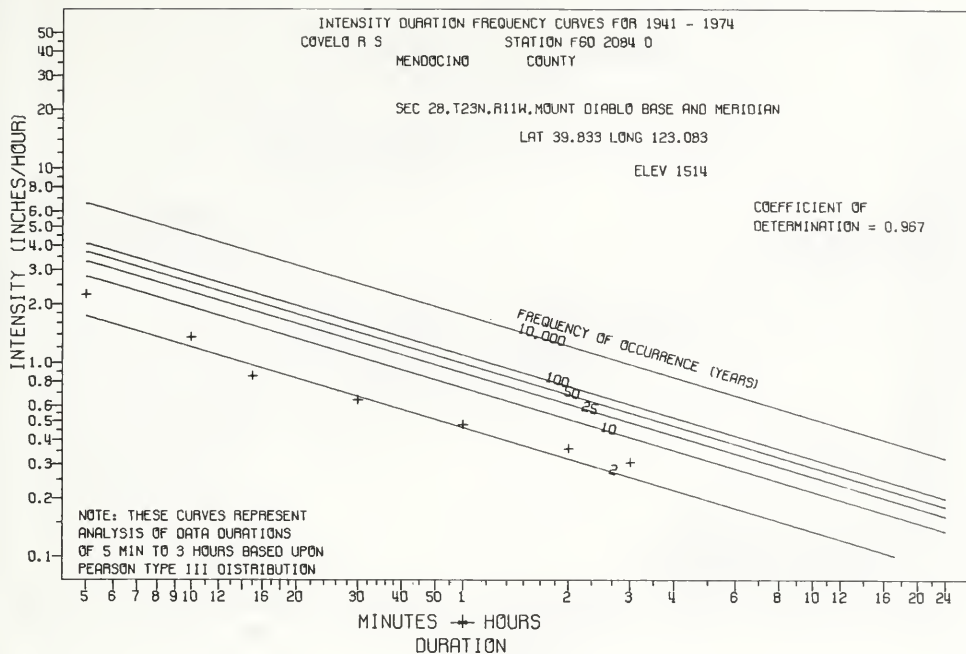


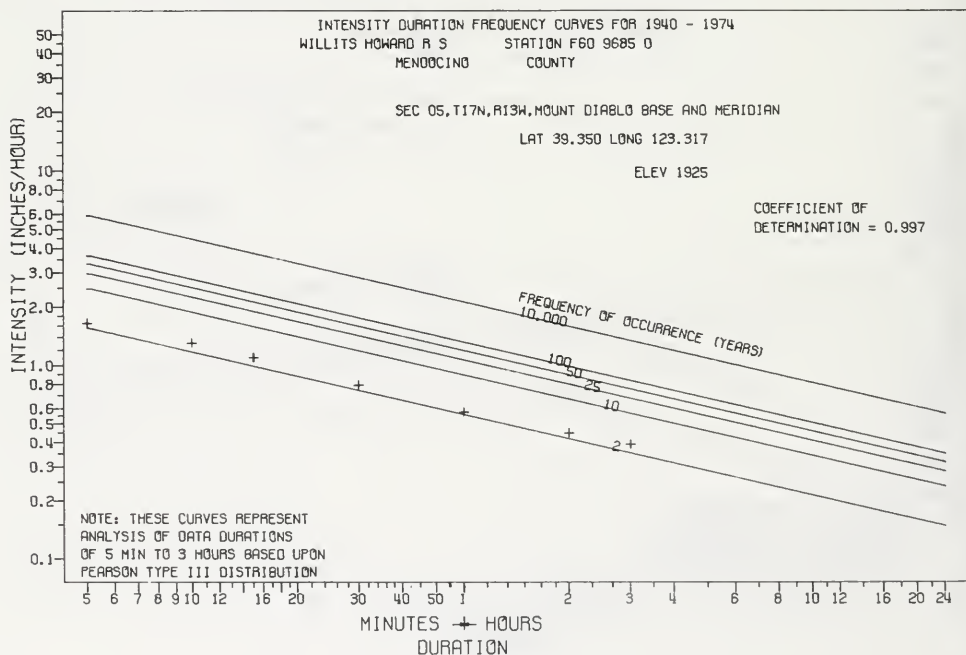
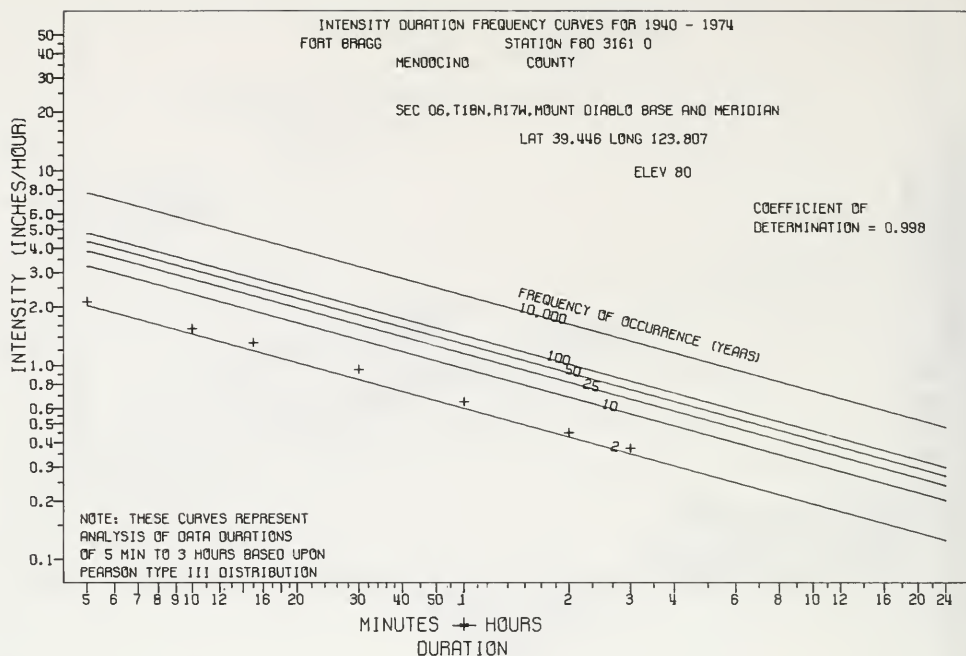


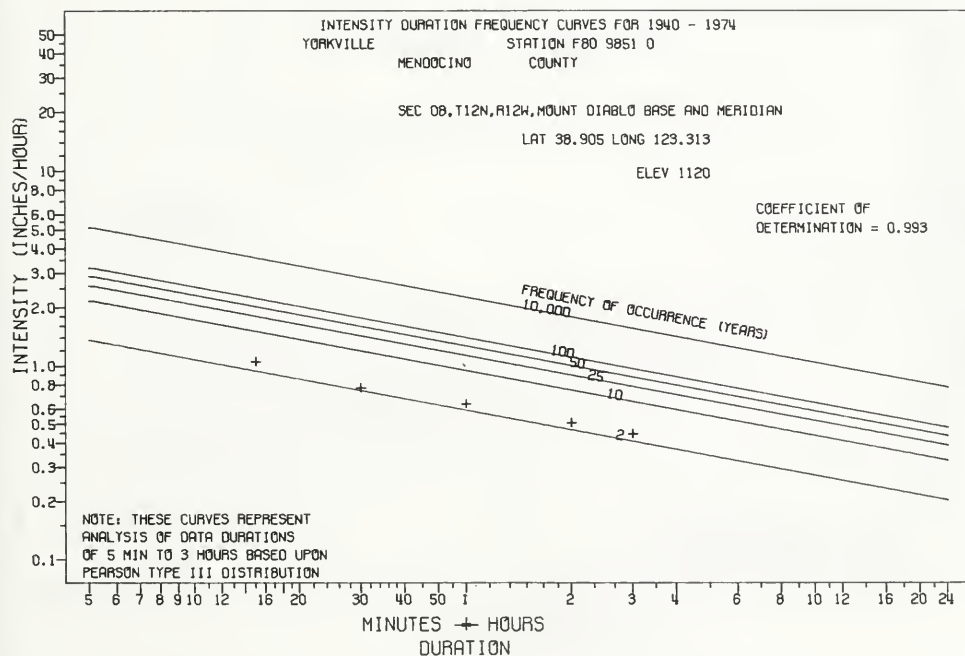
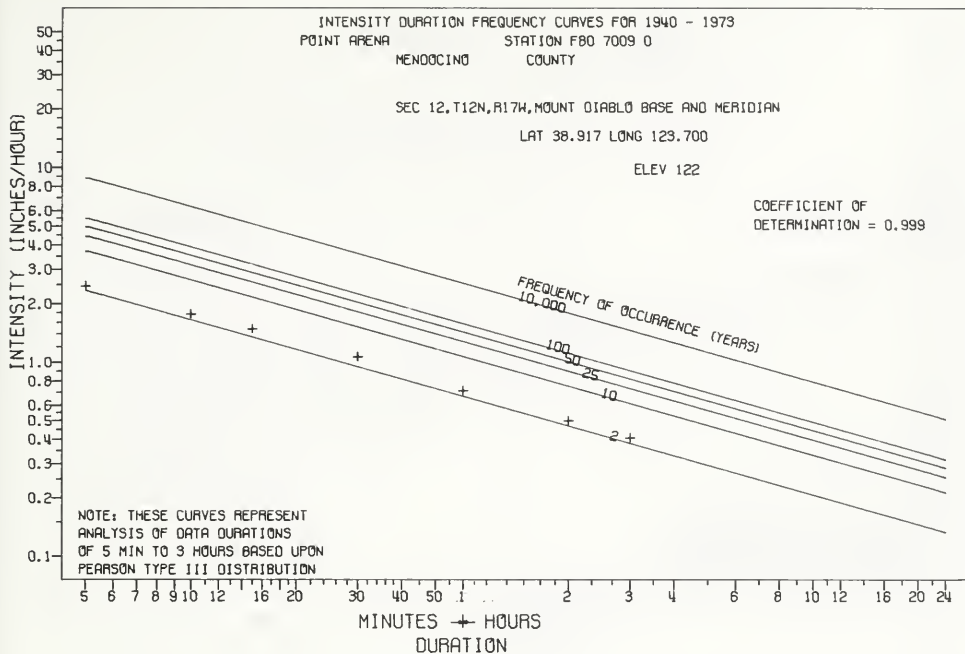


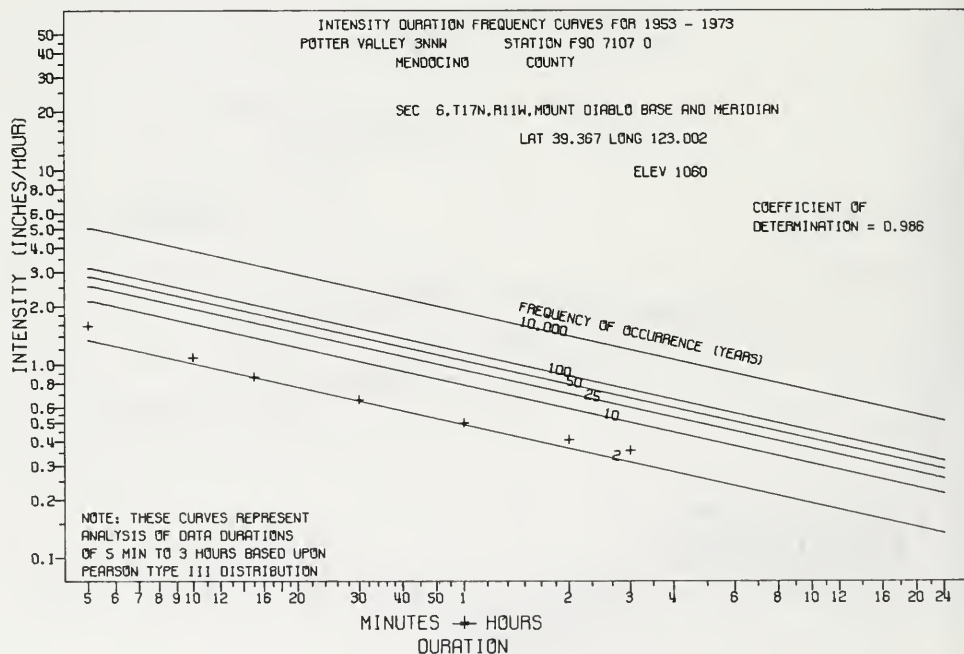
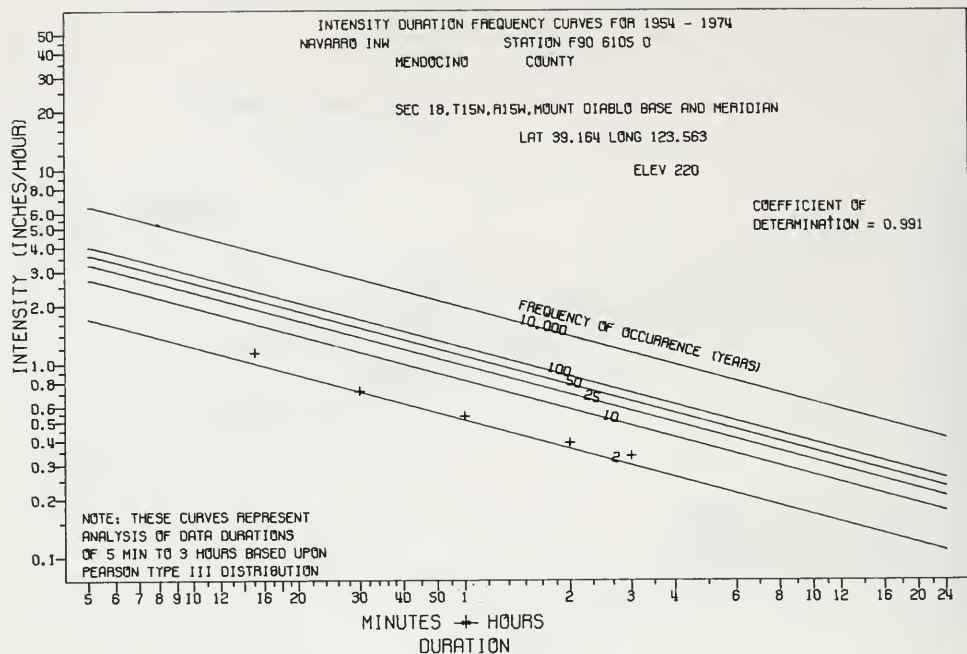














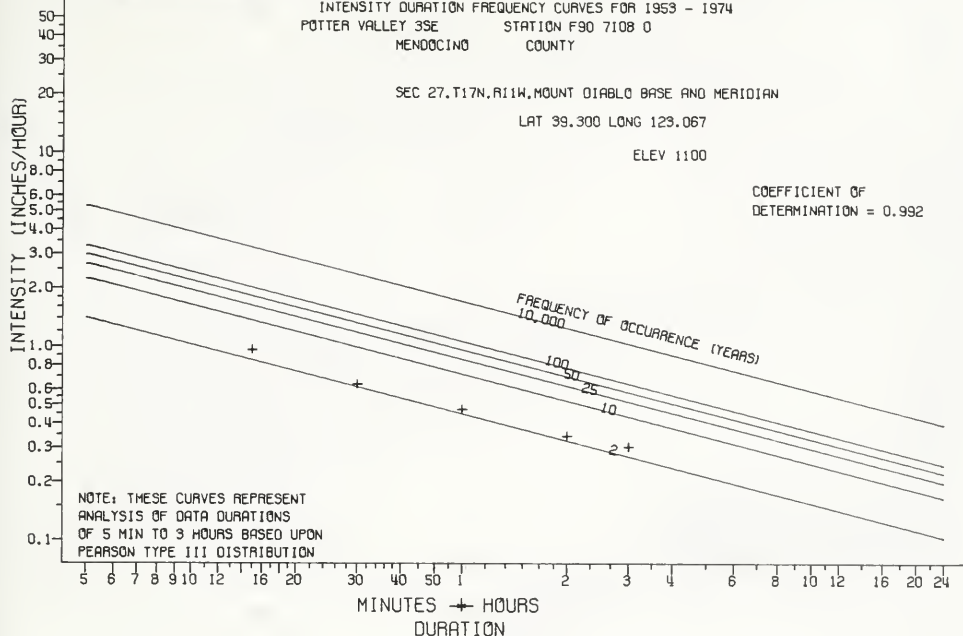
INTENSITY DURATION FREQUENCY CURVES FOR 1953 - 1974  
POTTER VALLEY 3SE STATION F90 7108 0  
MENDOCINO COUNTY

SEC 27, T17N, R11W, MOUNT DIABLO BASE AND MERIDIAN

LAT 39.300 LONG 123.067

ELEV 1100

COEFFICIENT OF  
DETERMINATION = 0.992



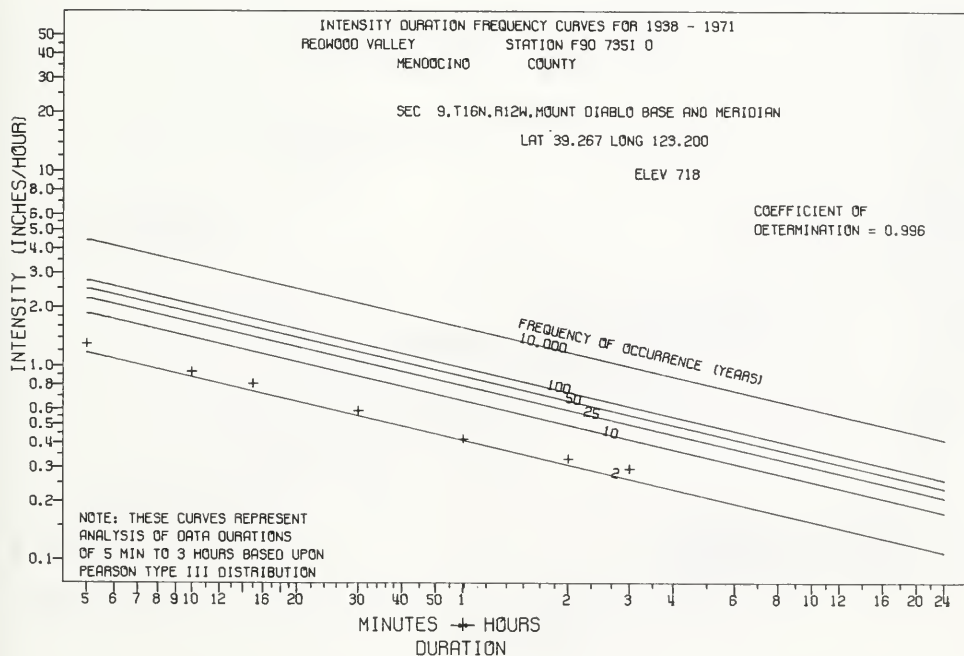
INTENSITY DURATION FREQUENCY CURVES FOR 1938 - 1971  
REDWOOD VALLEY STATION F90 7351 0  
MENDOCINO COUNTY

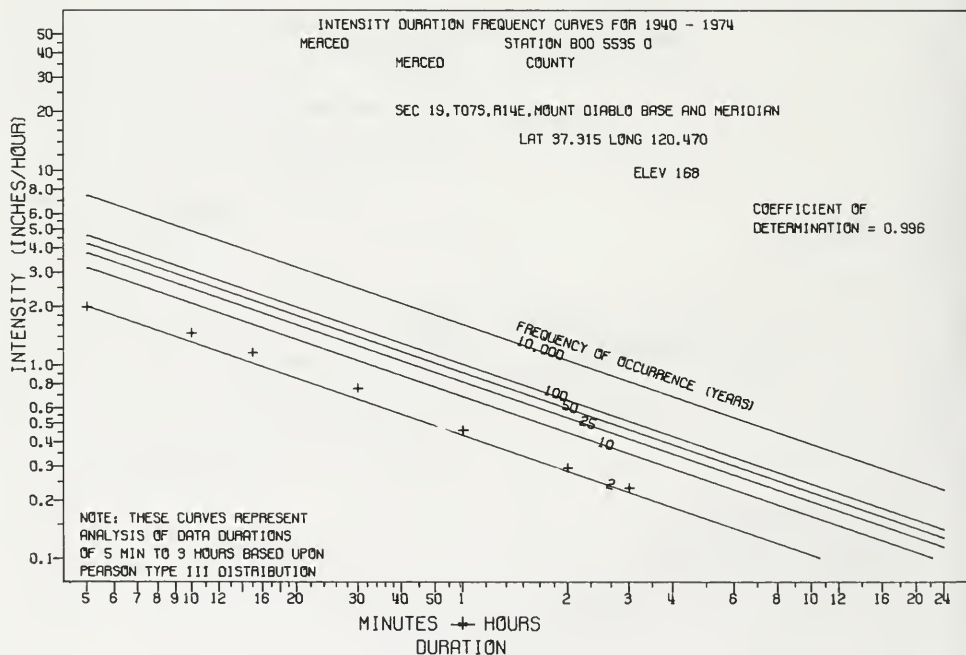
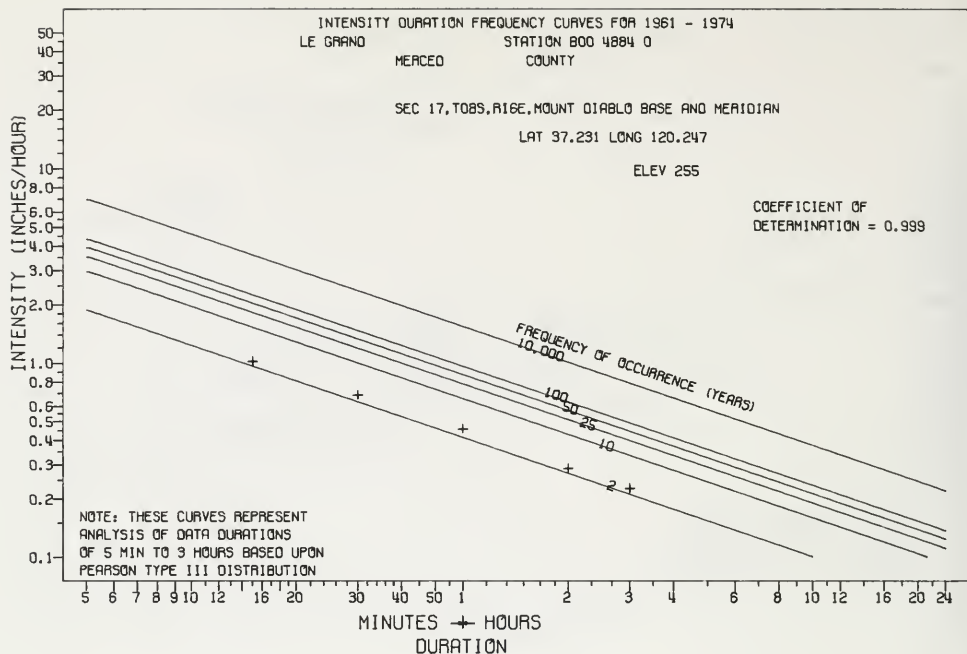
SEC 9, T16N, R12W, MOUNT DIABLO BASE AND MERIDIAN

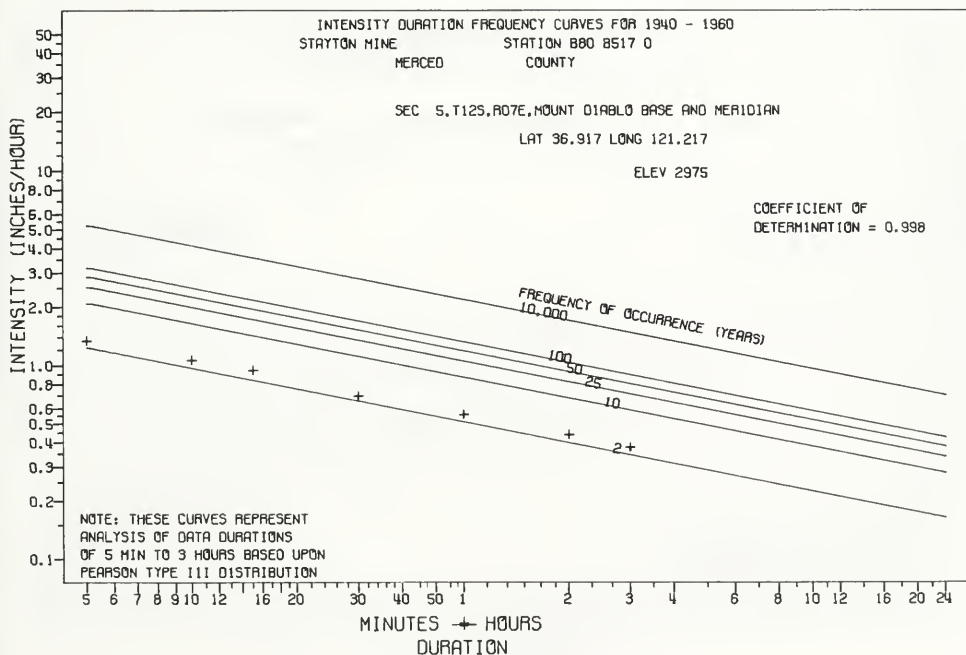
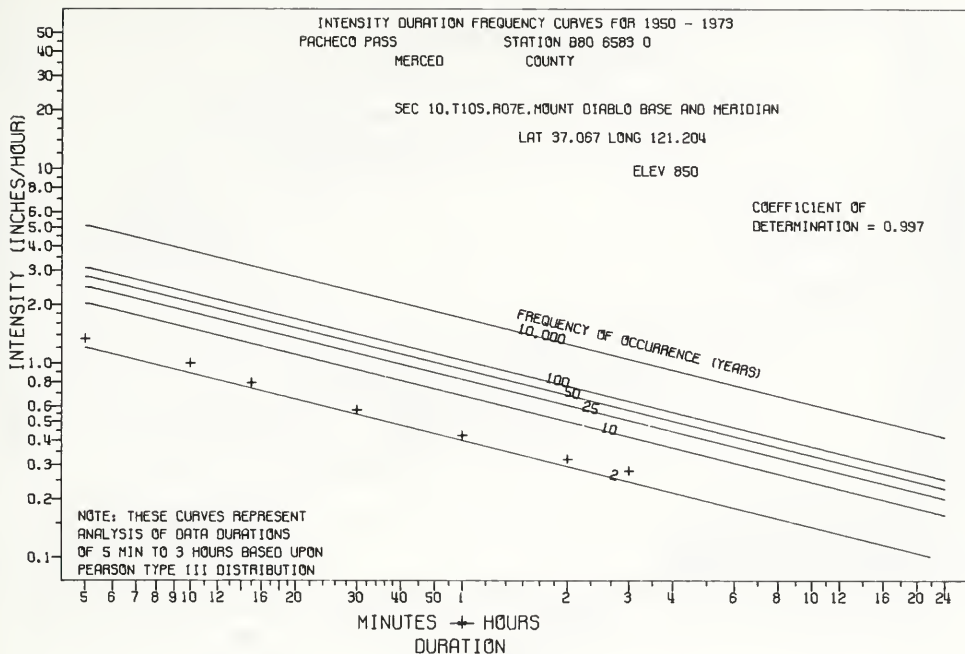
LAT 39.267 LONG 123.200

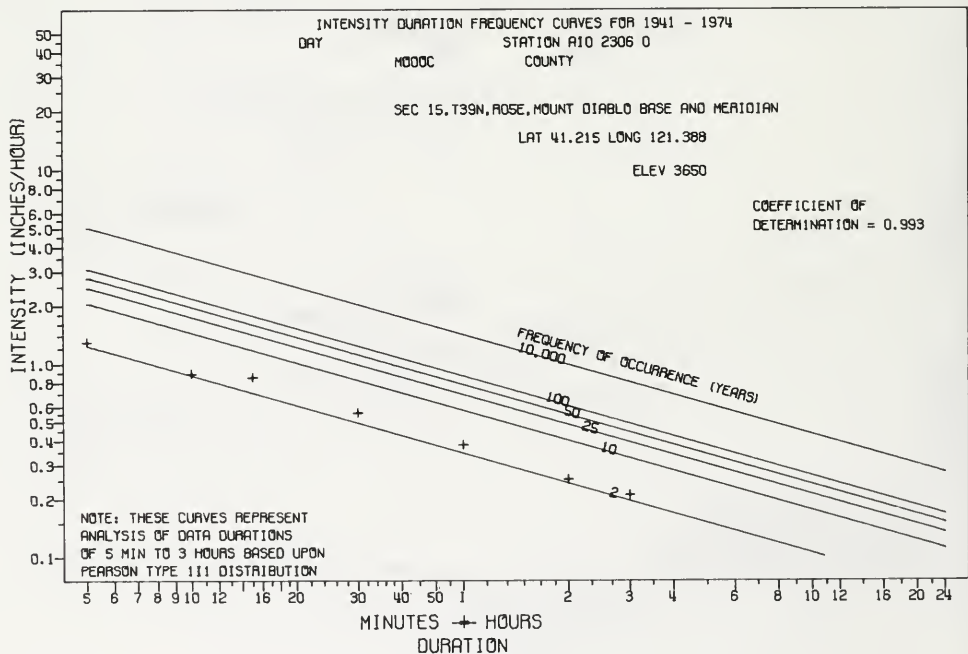
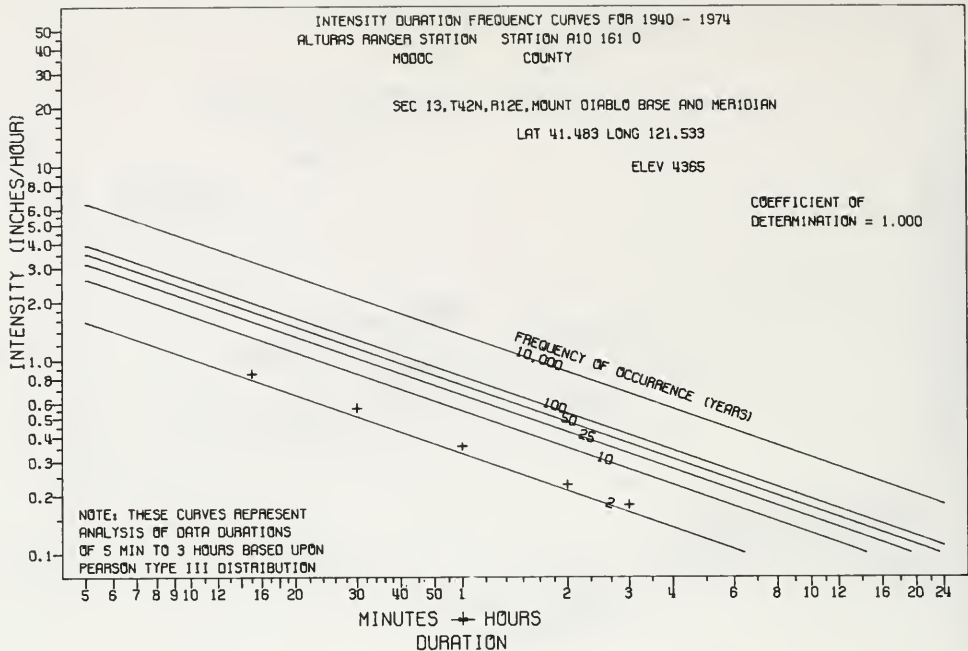
ELEV 718

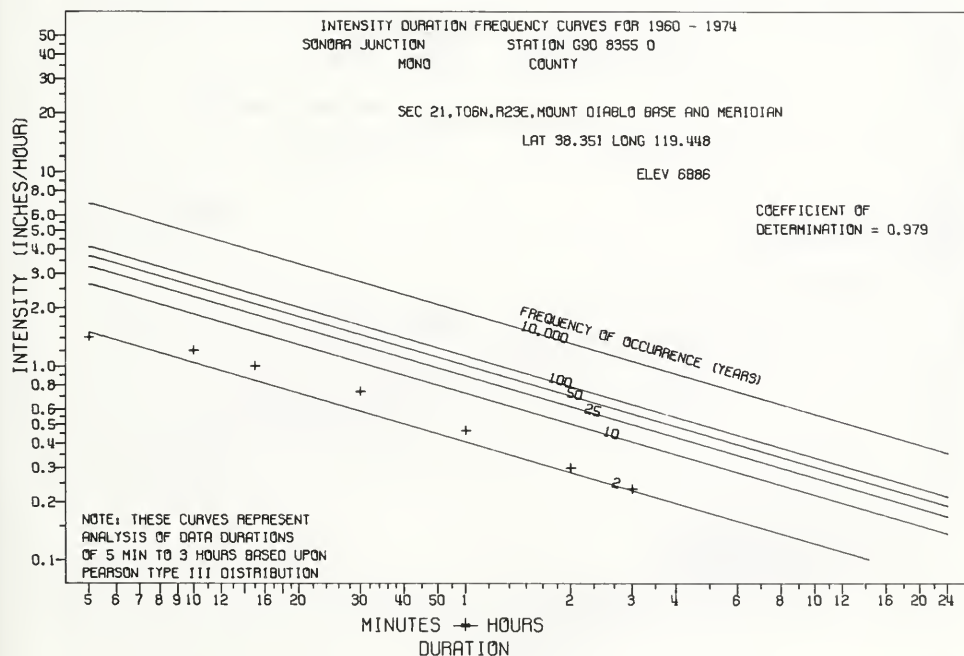
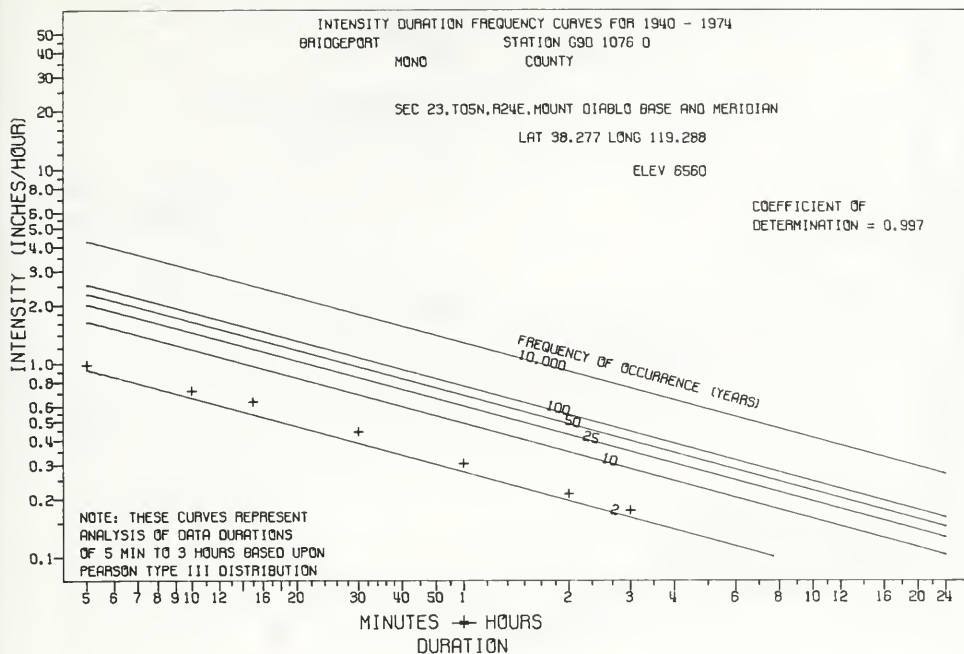
COEFFICIENT OF  
DETERMINATION = 0.996

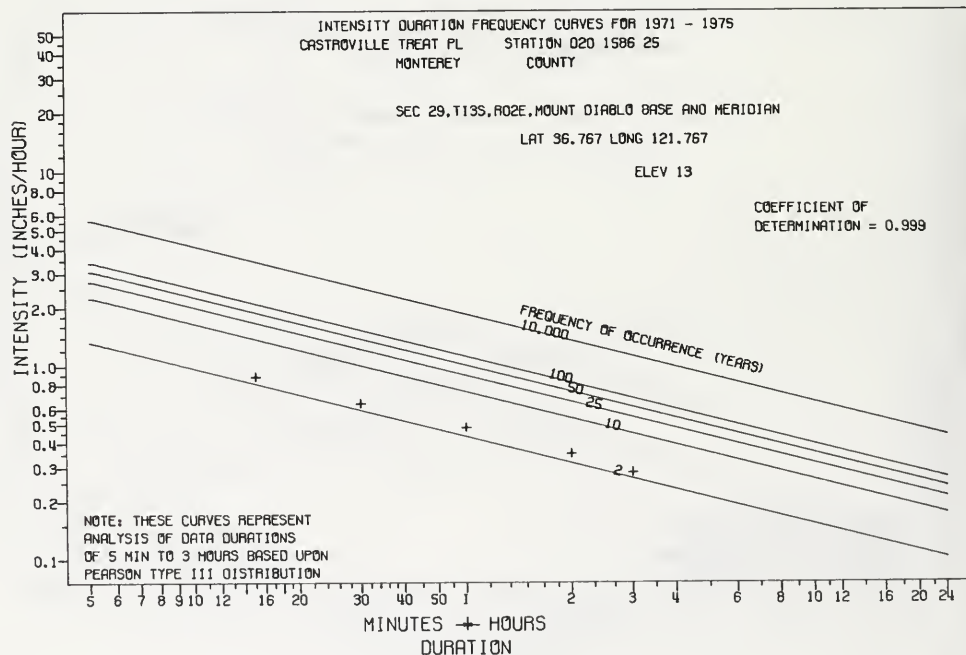
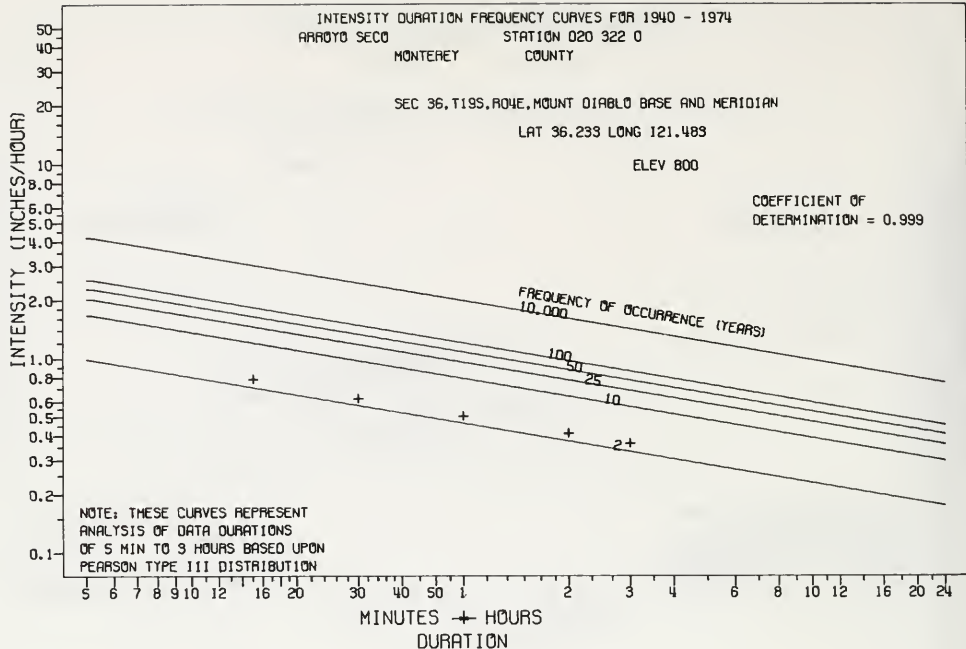


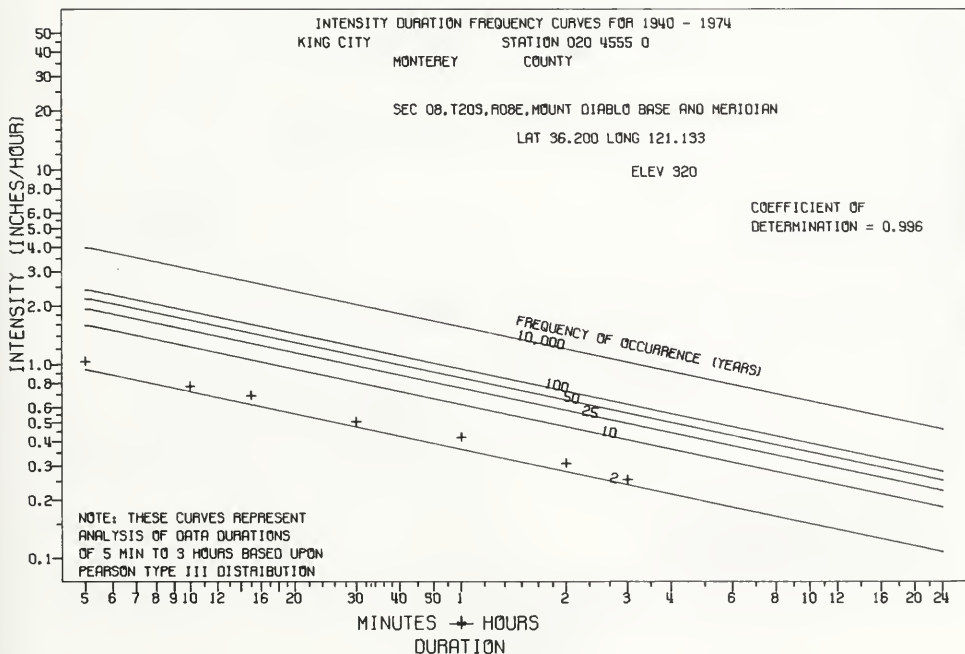
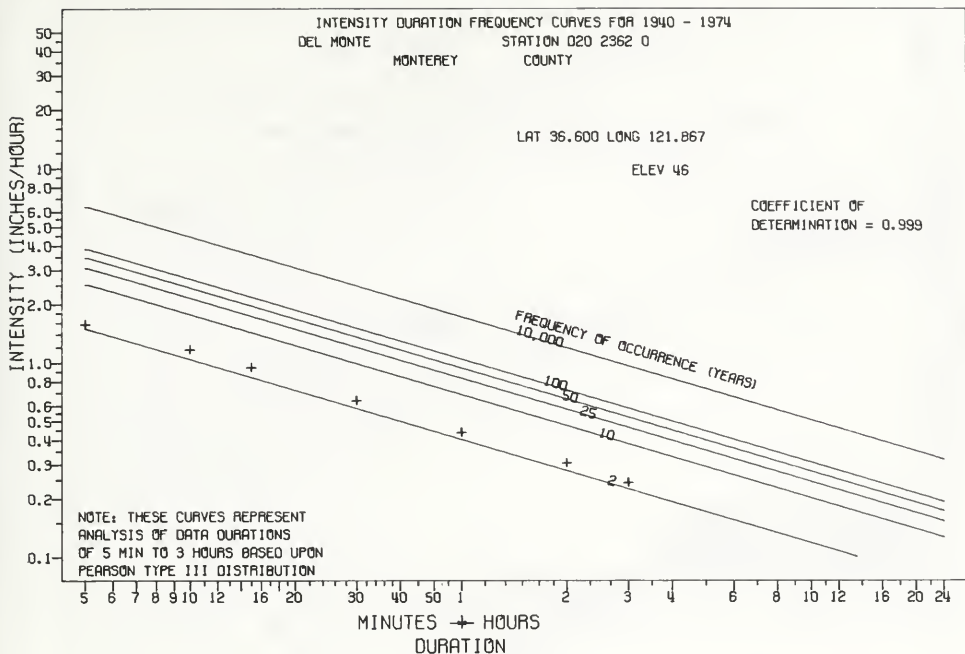




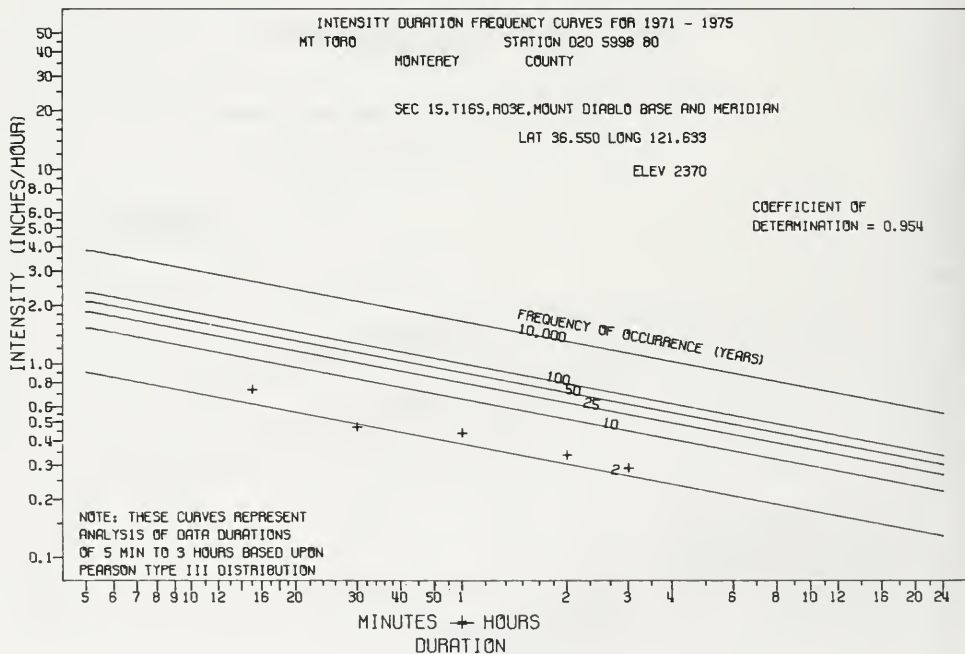
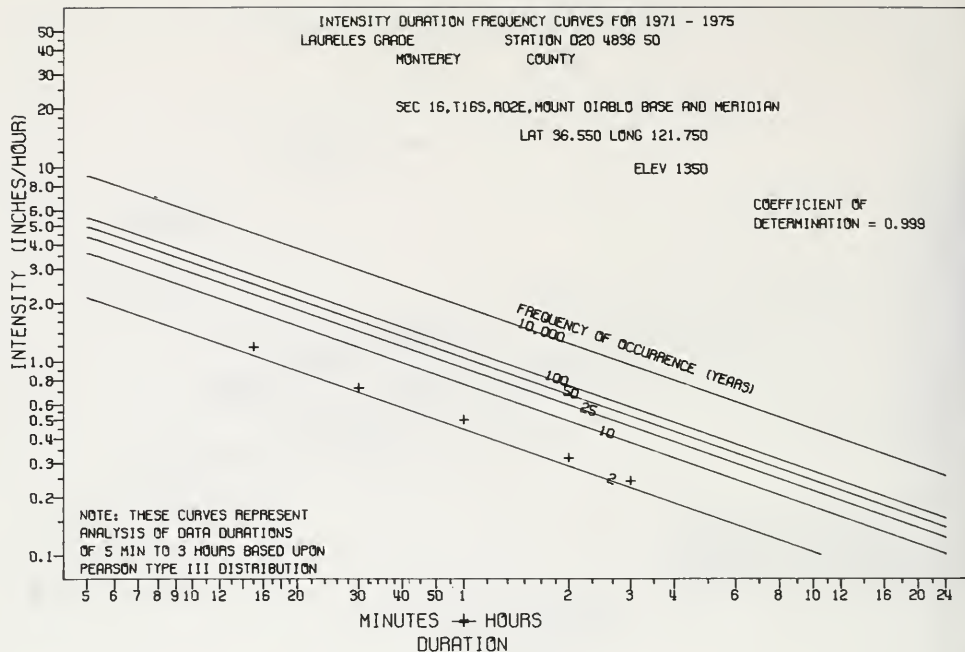




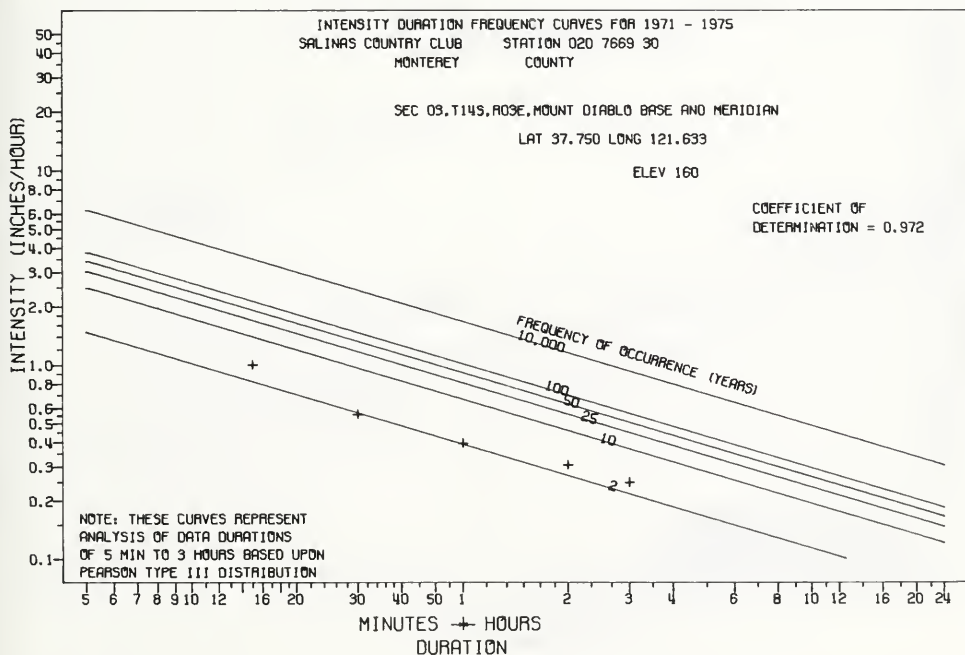
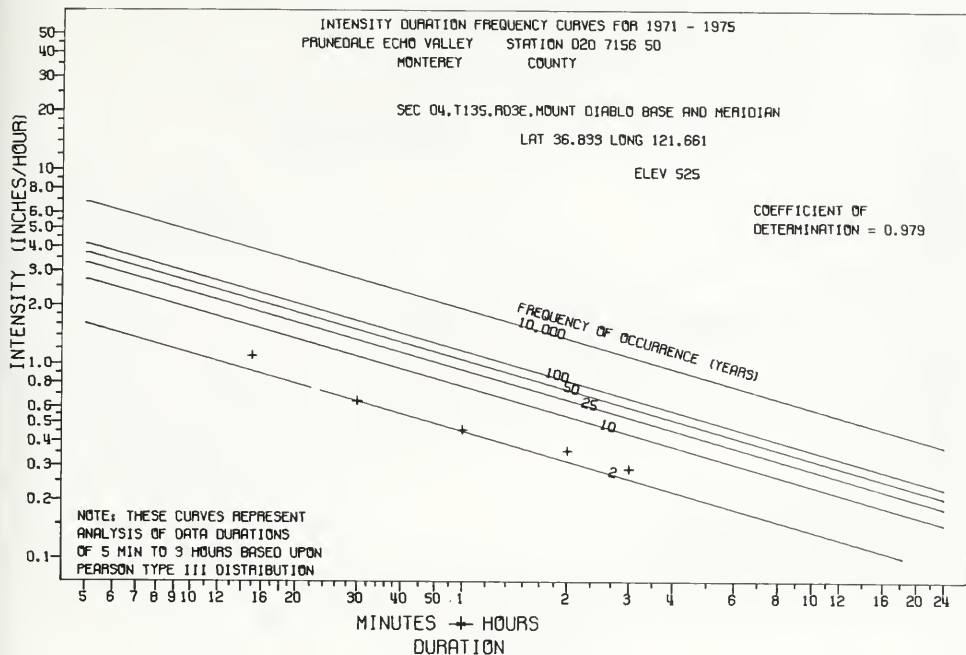


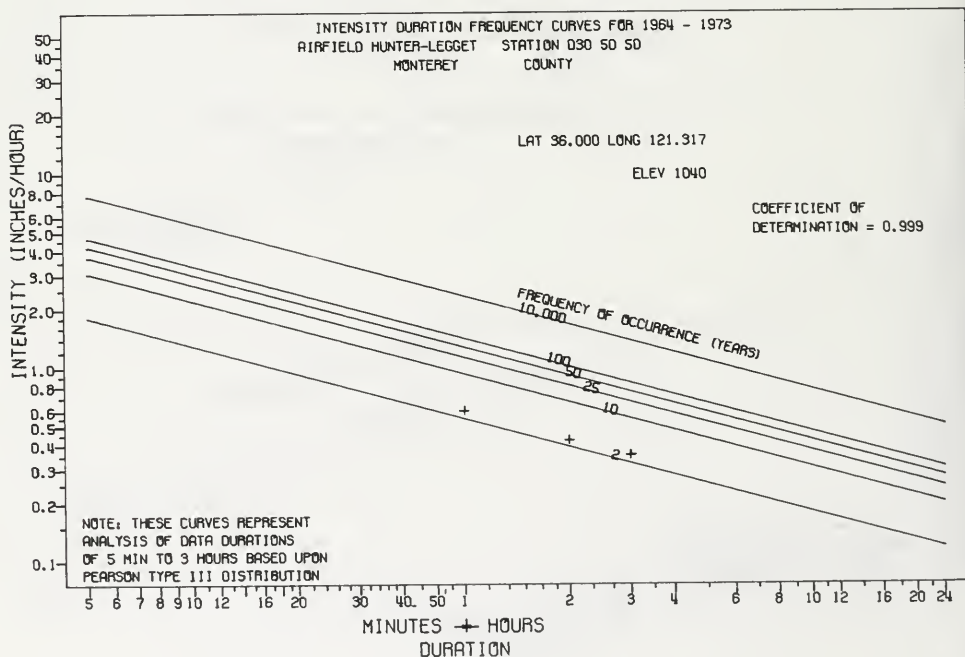
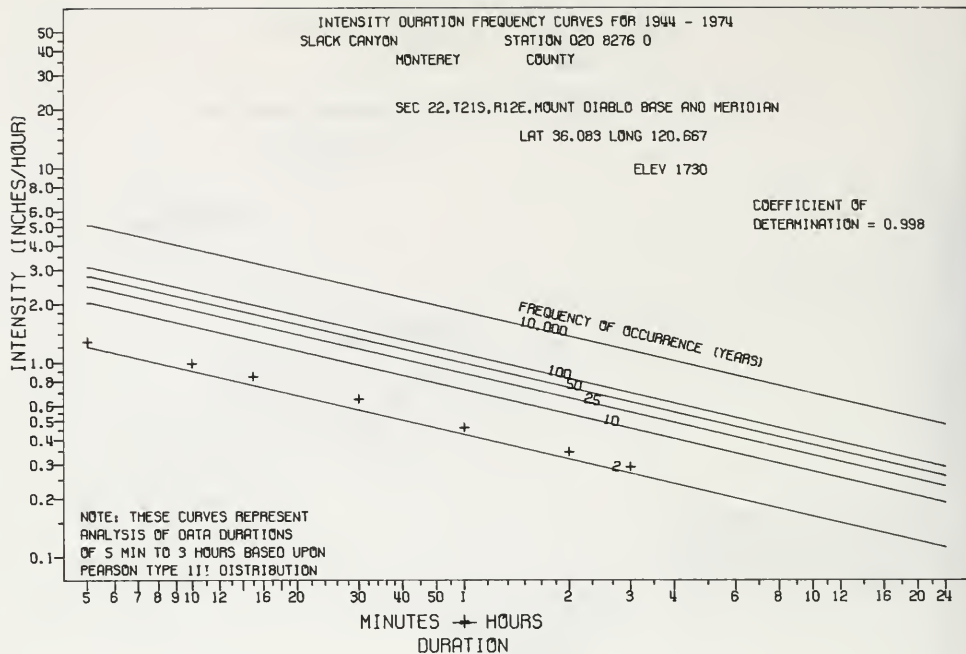


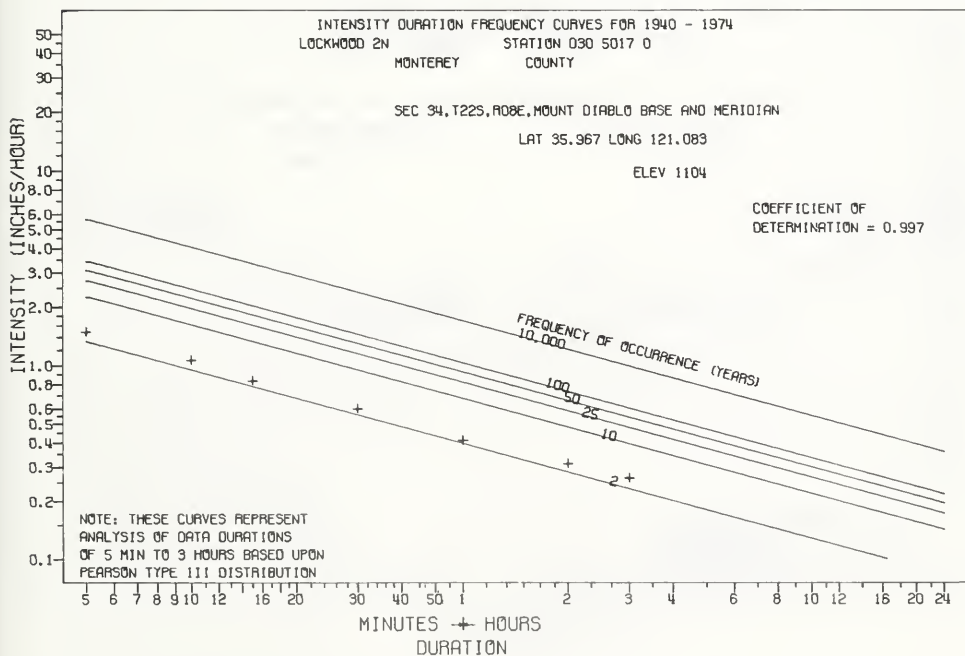
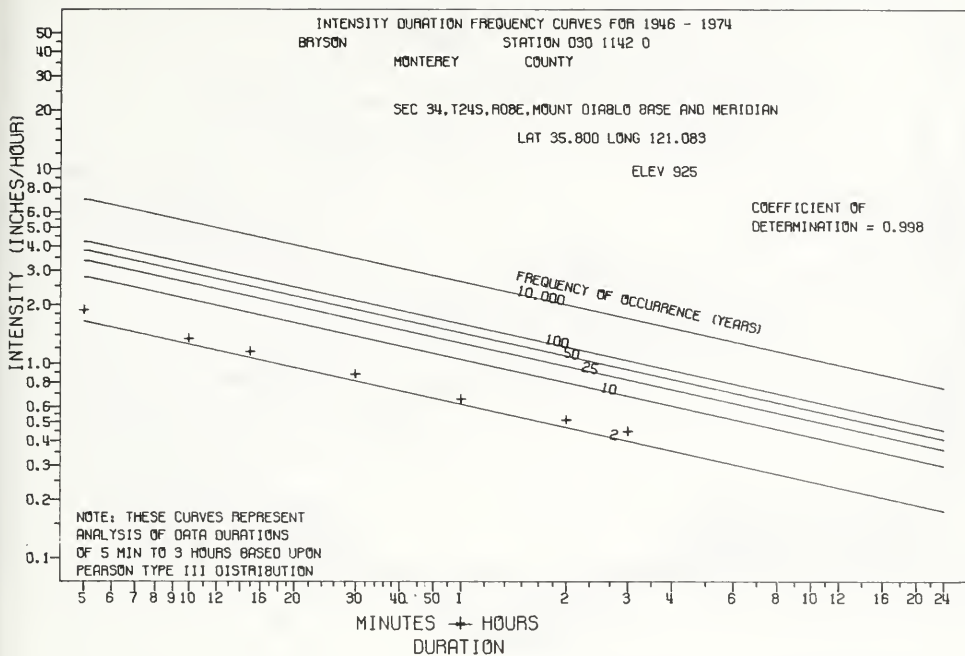


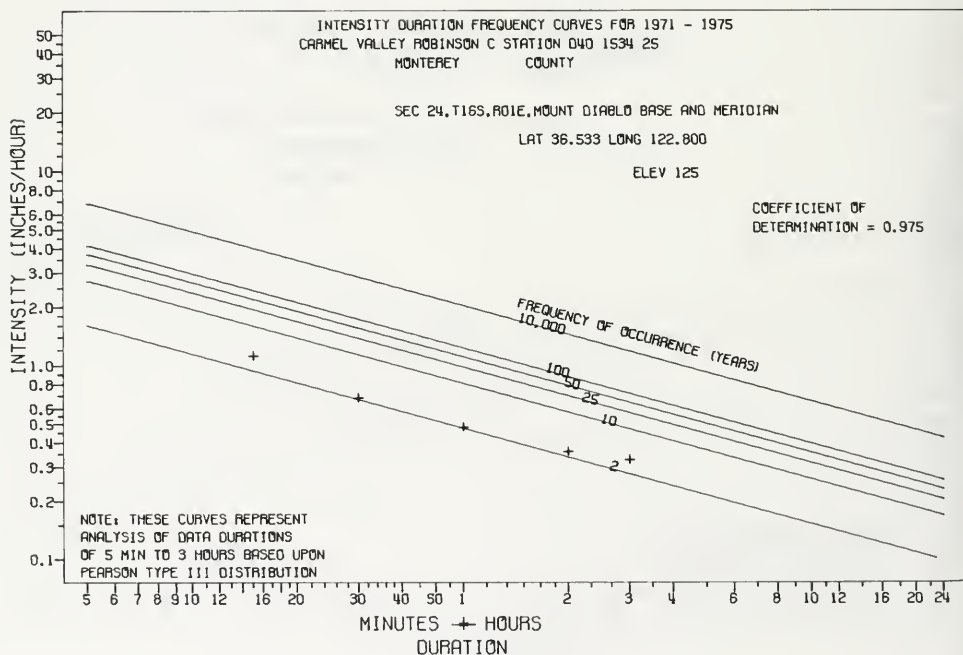
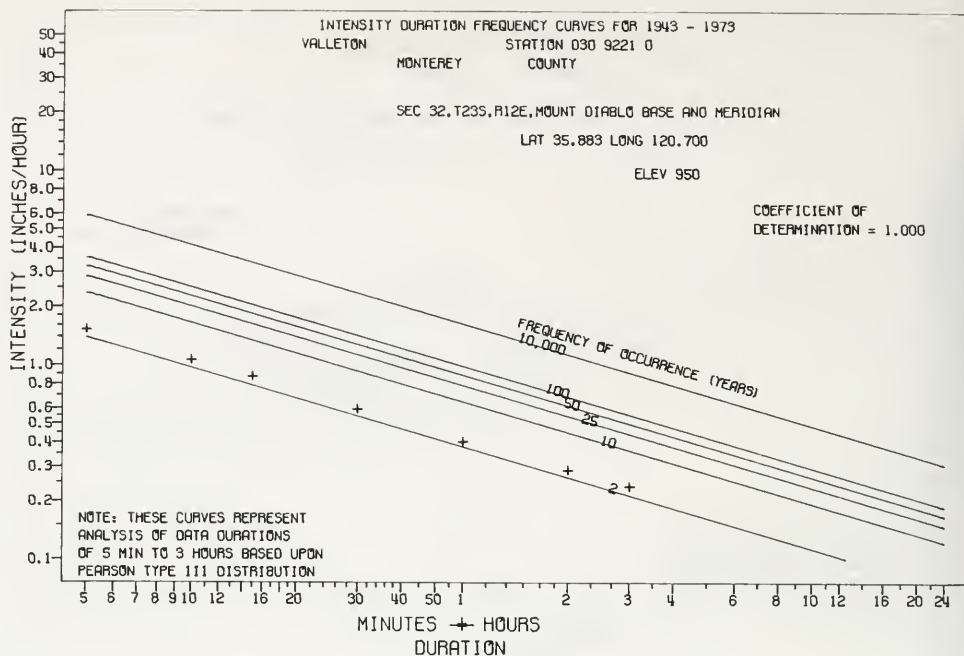


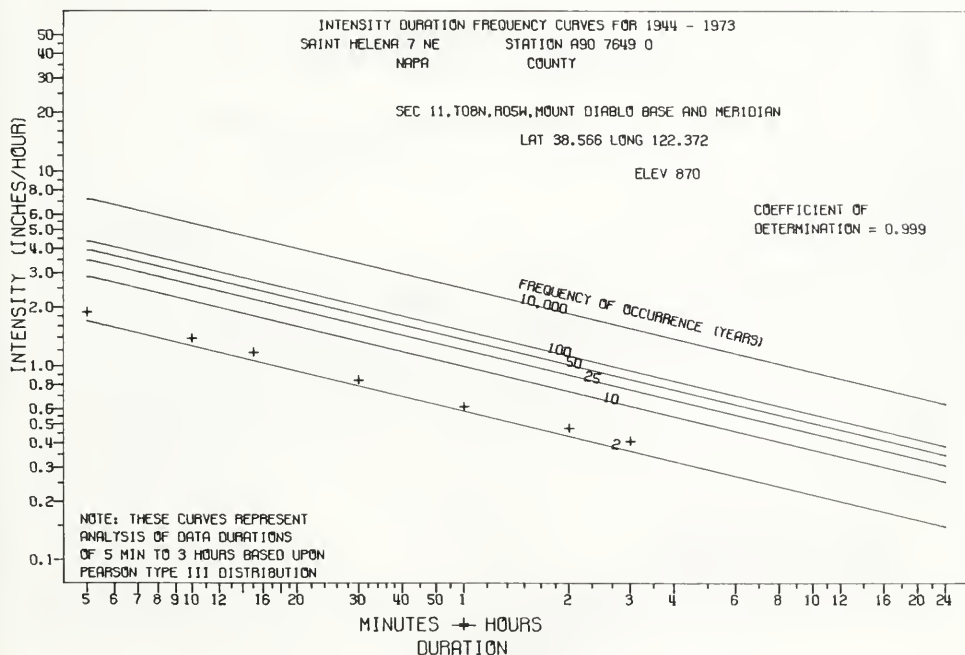
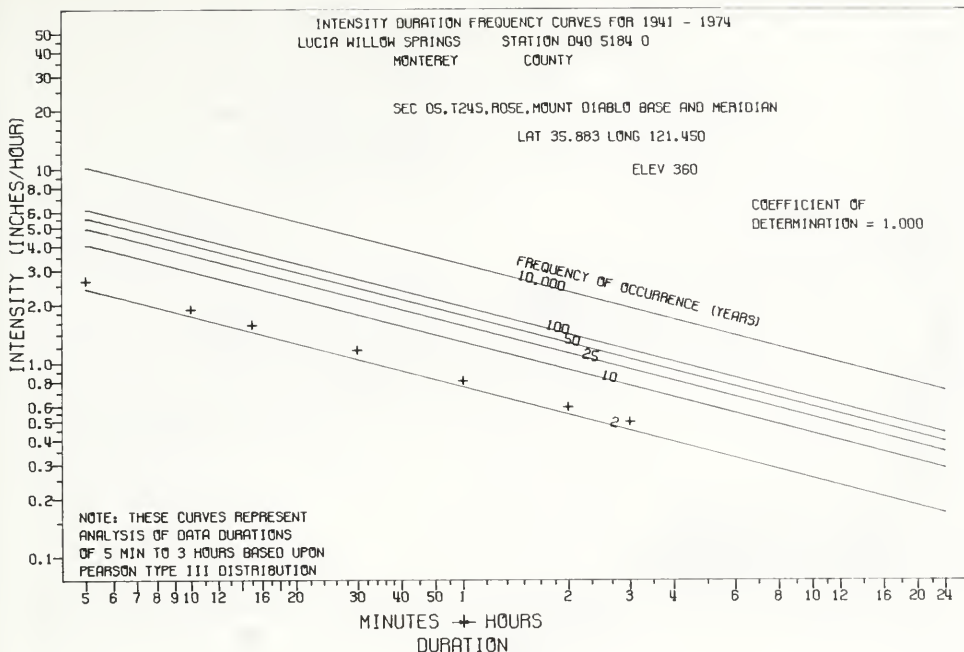


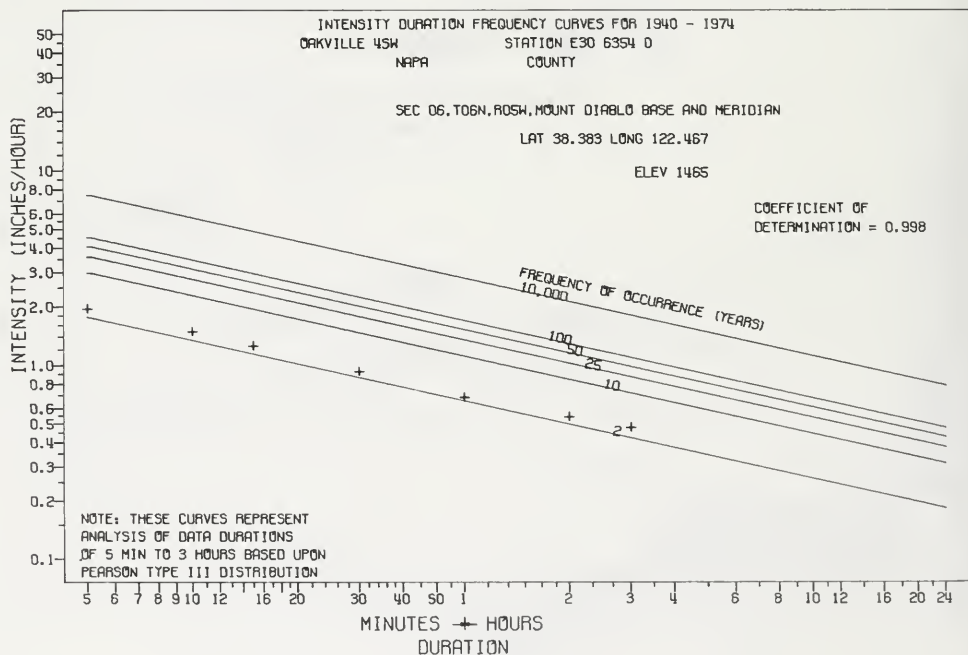
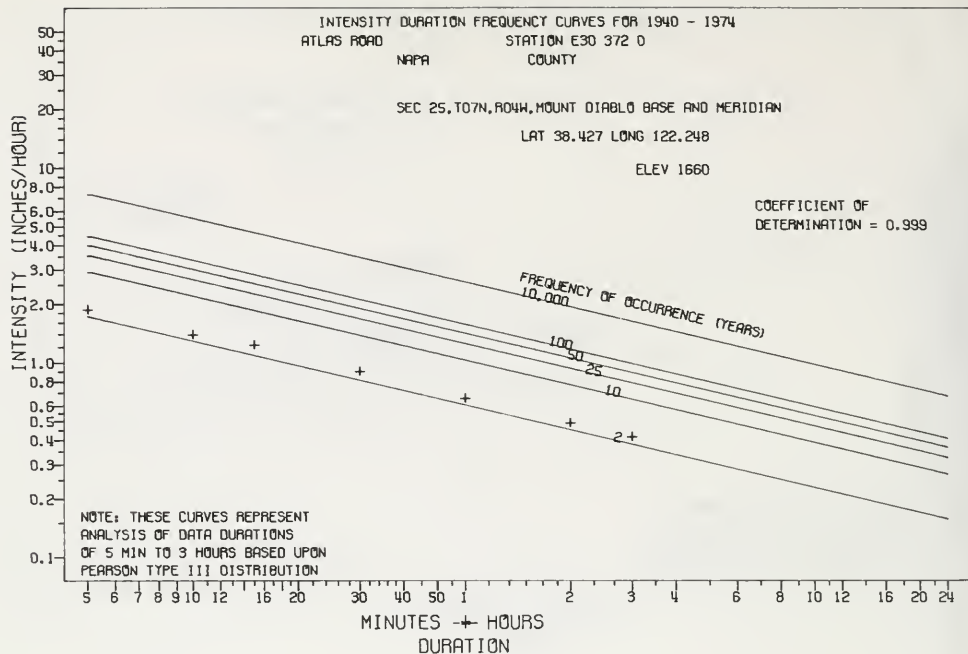


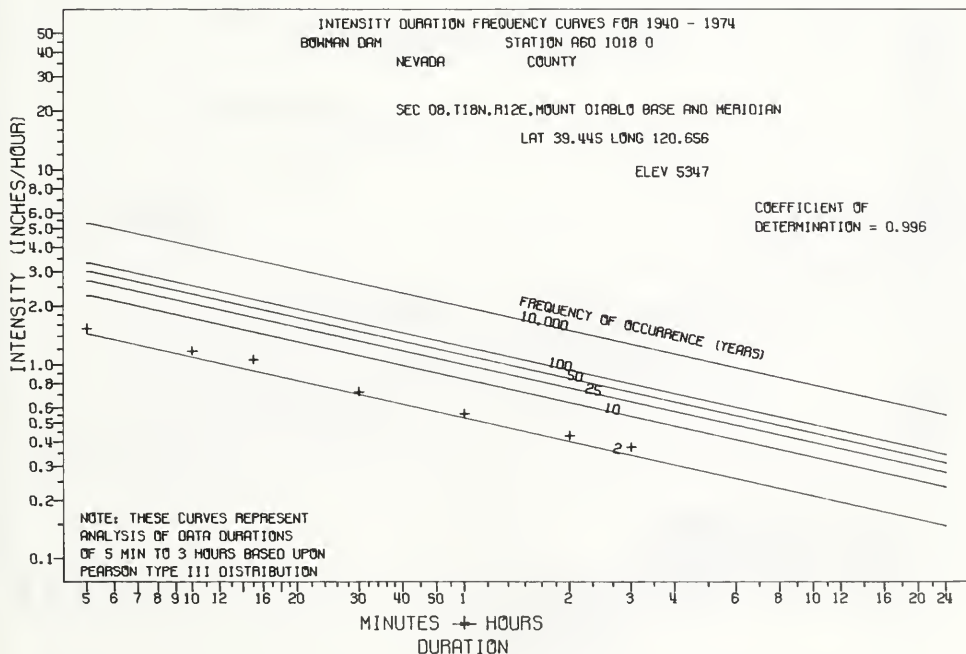
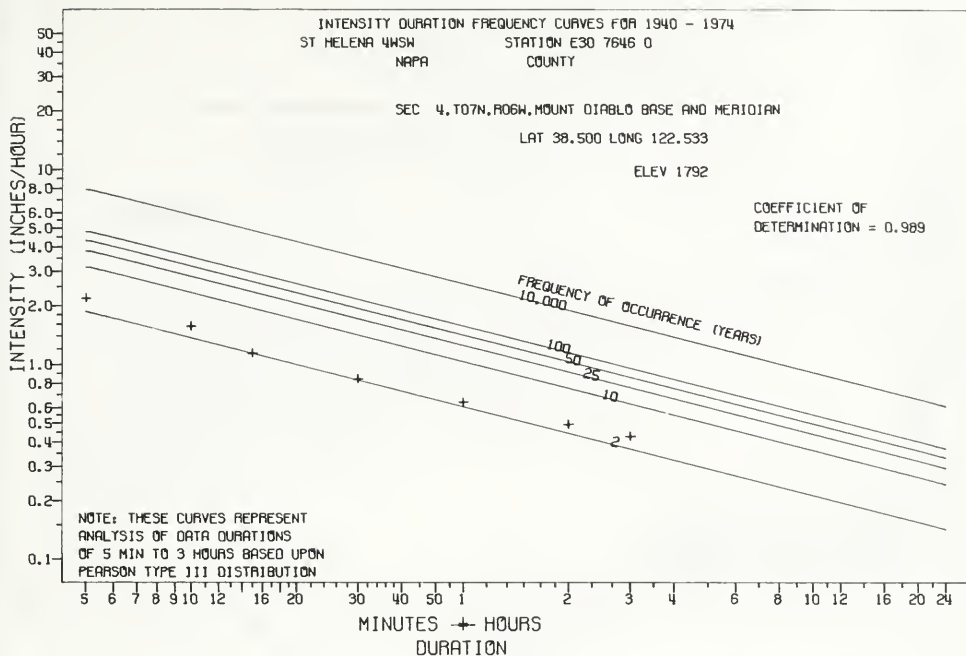




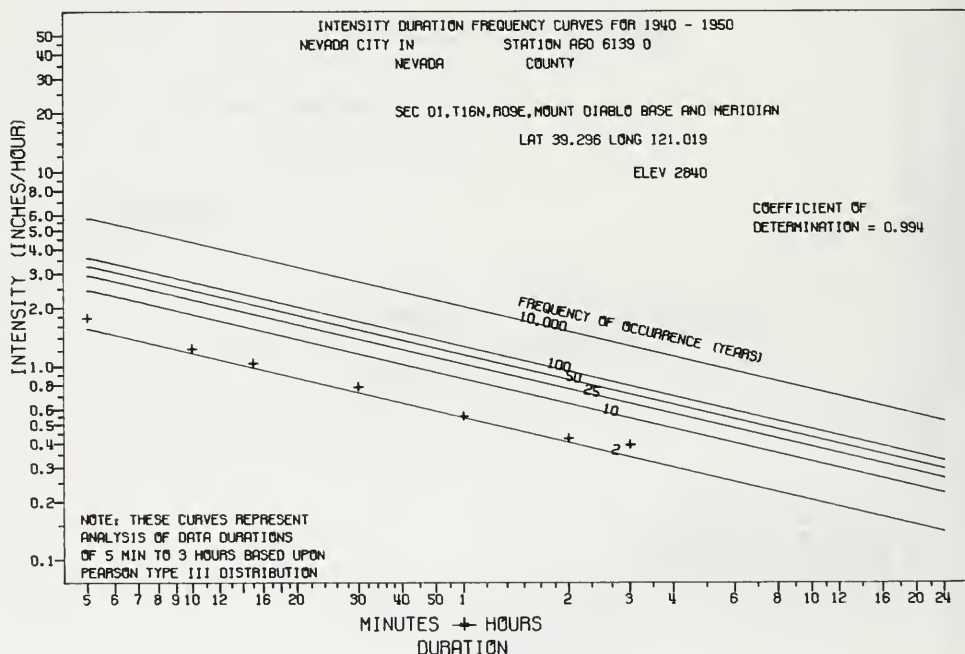
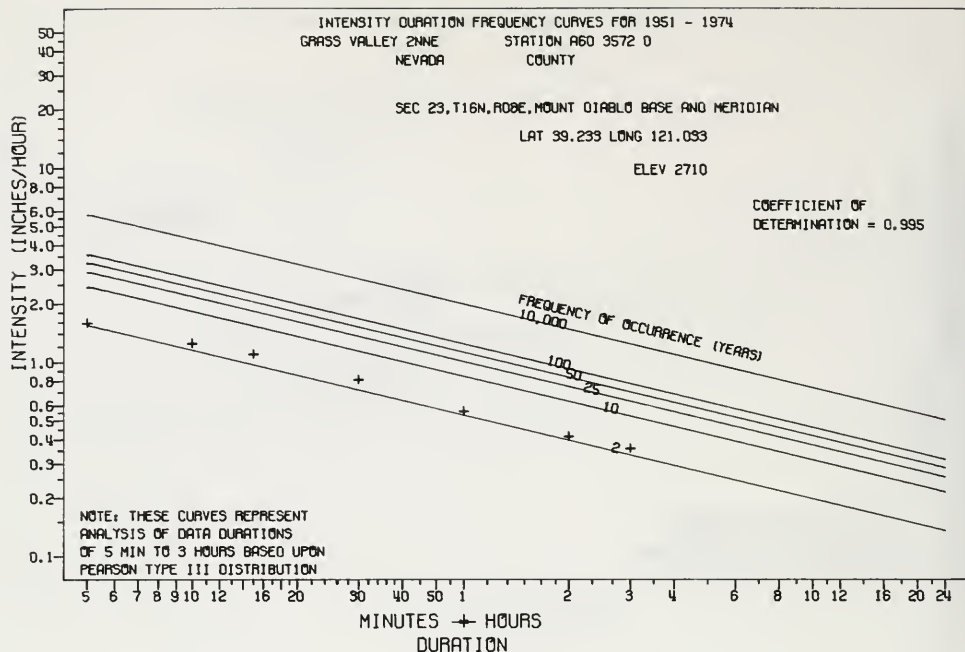




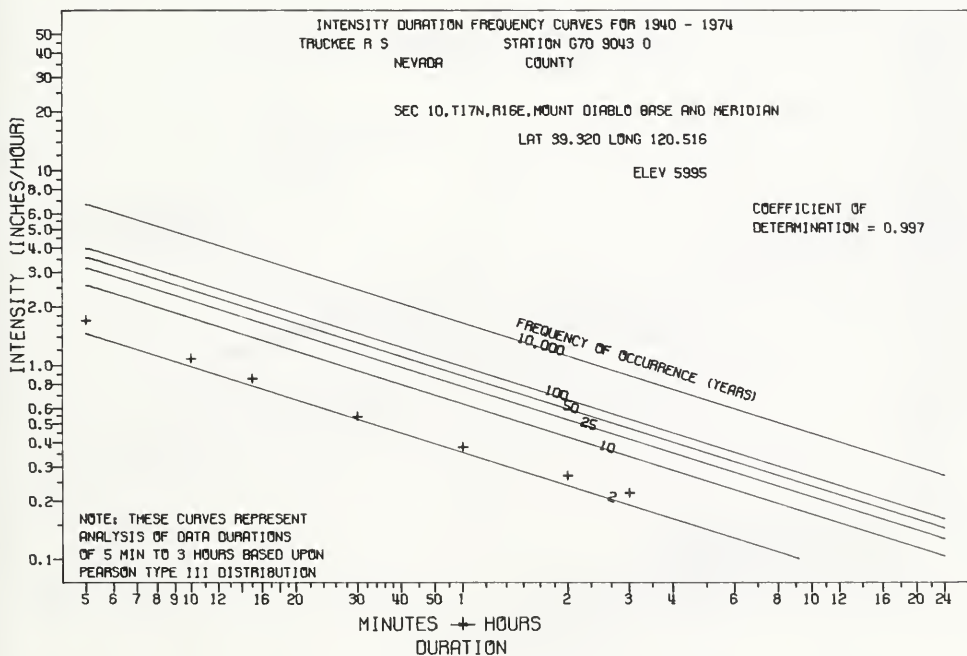
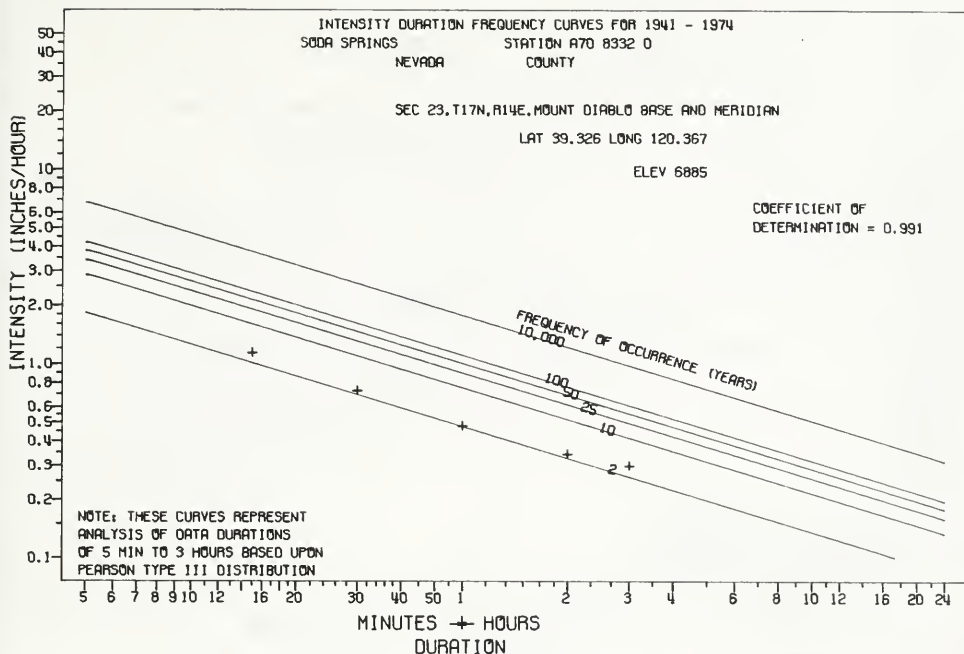


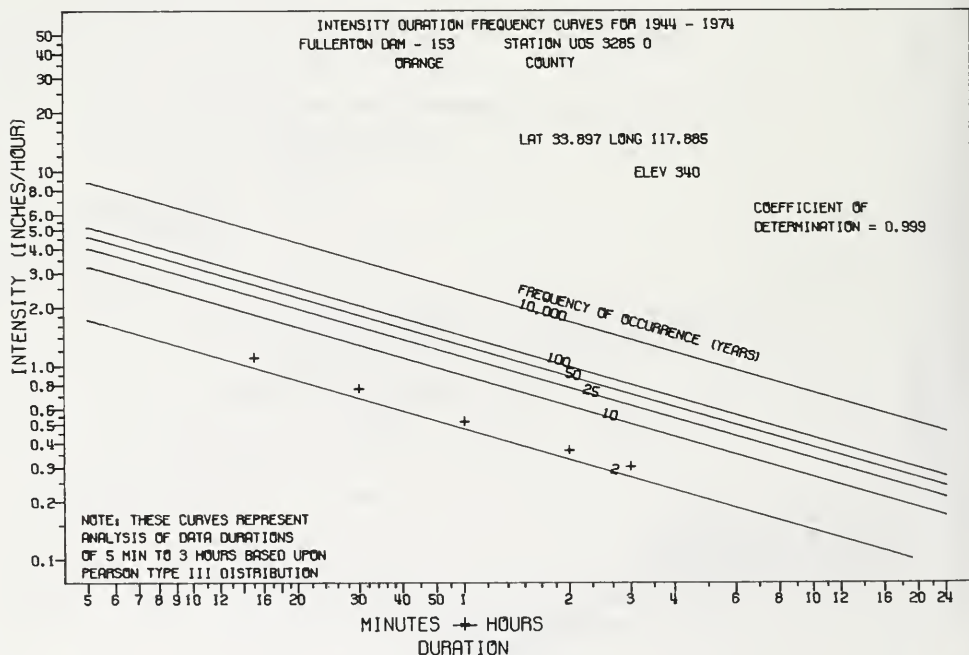
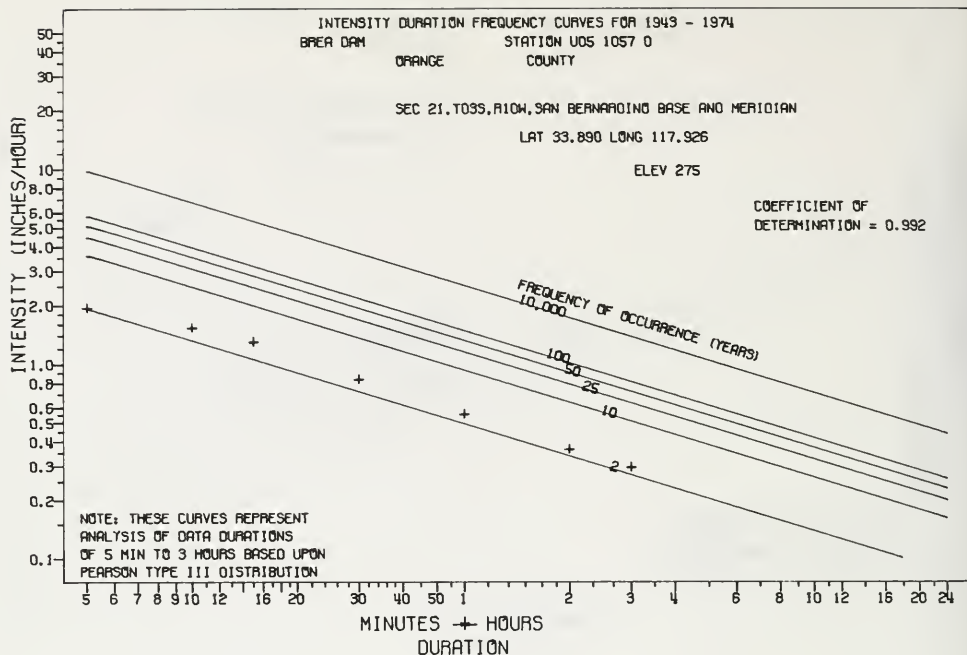


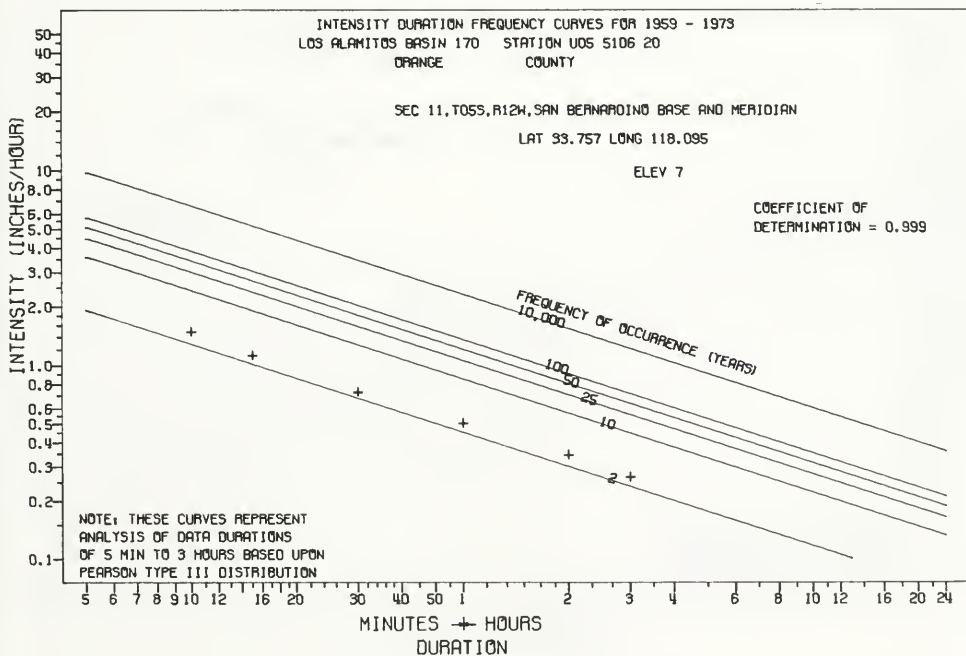
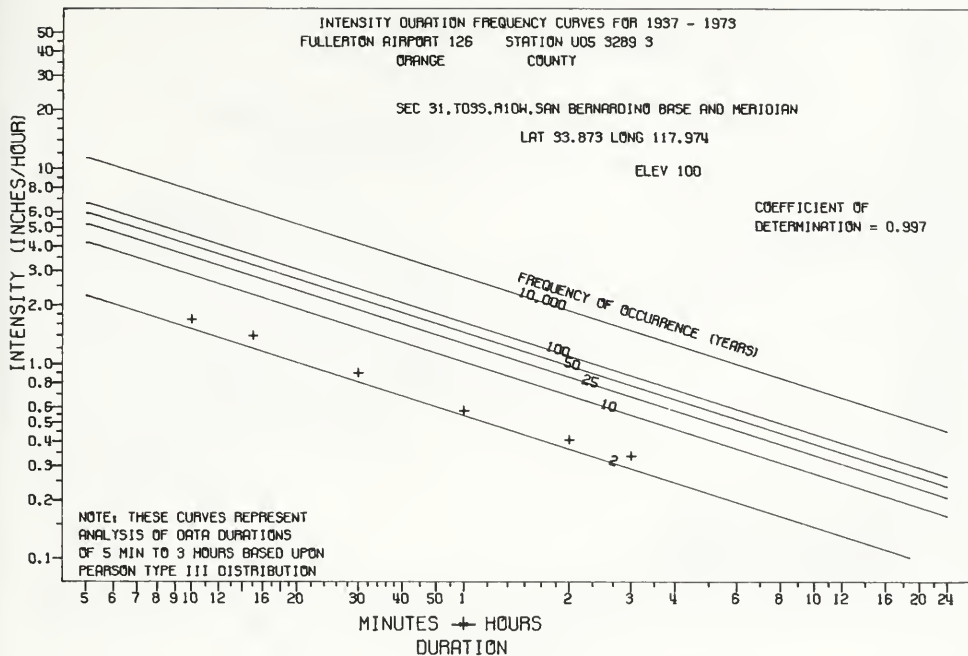


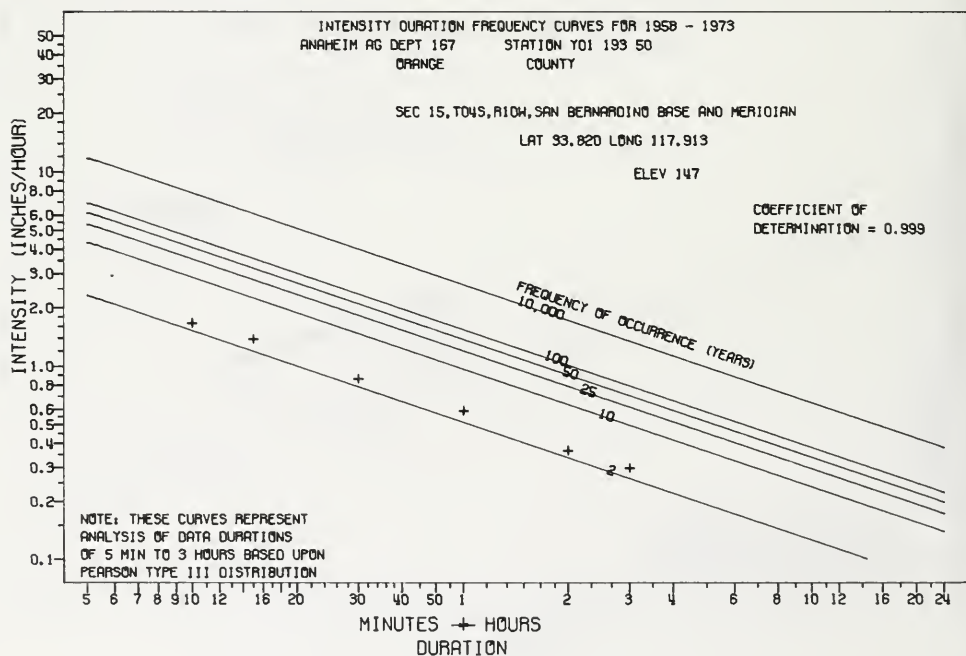
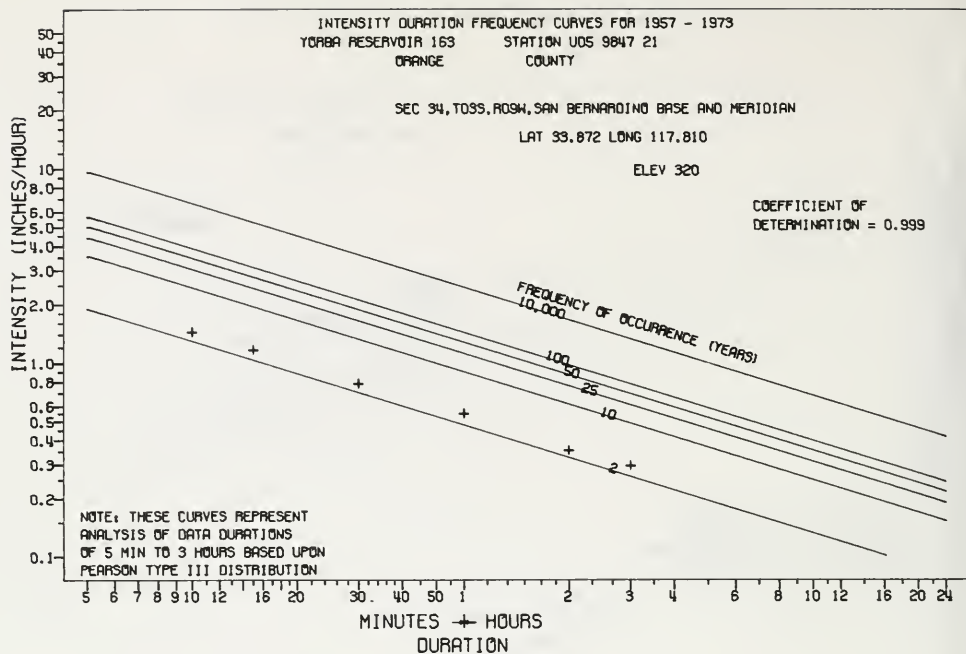


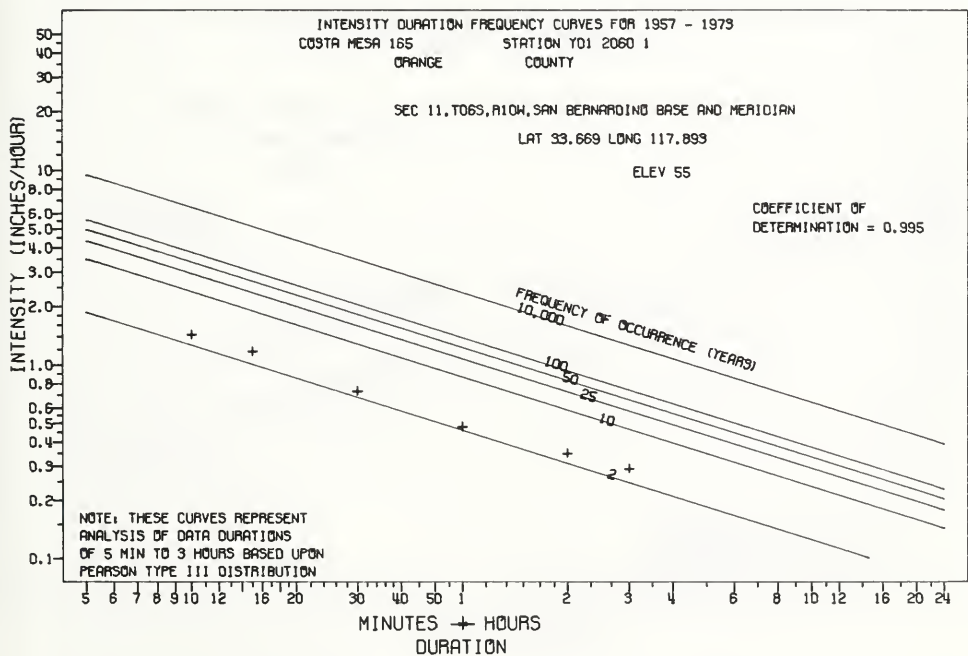
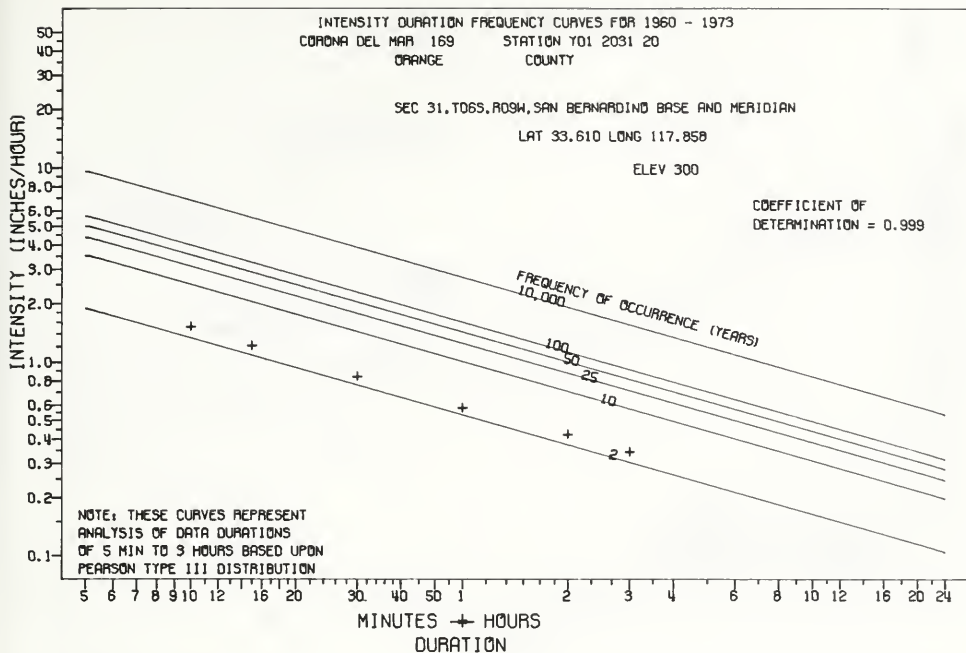


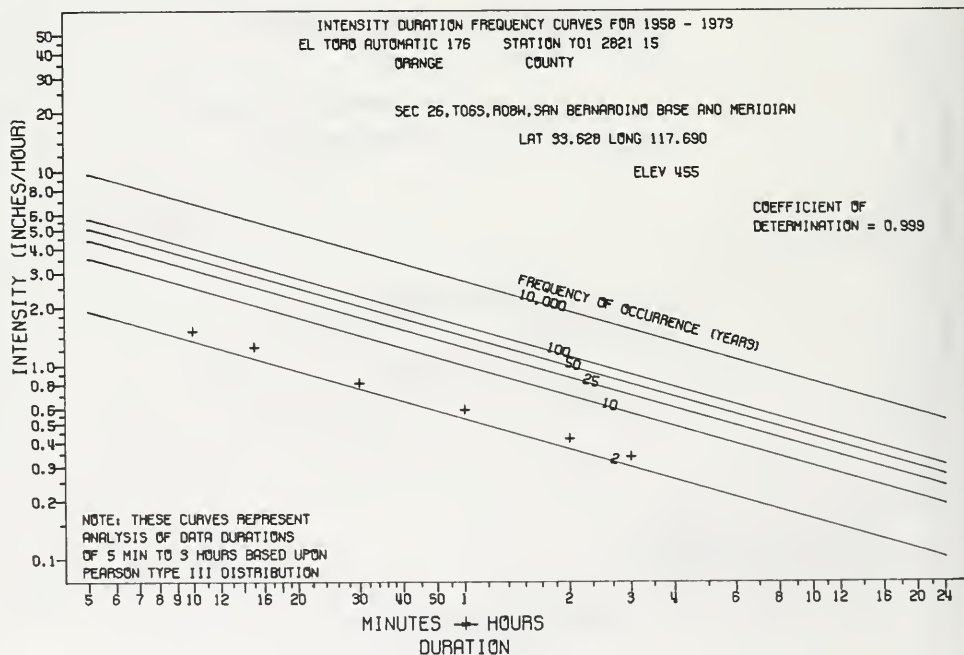
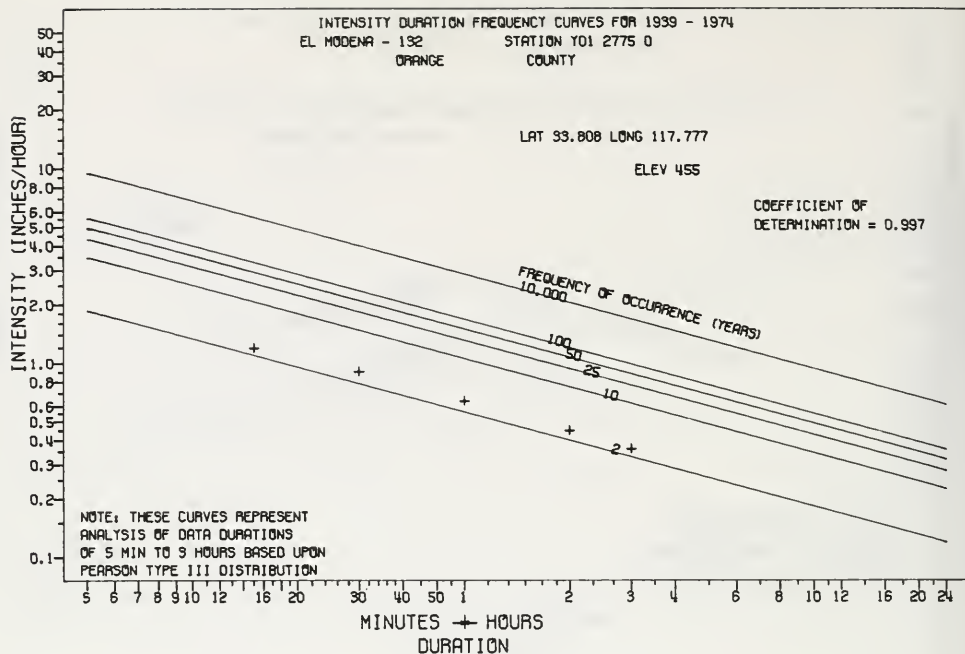


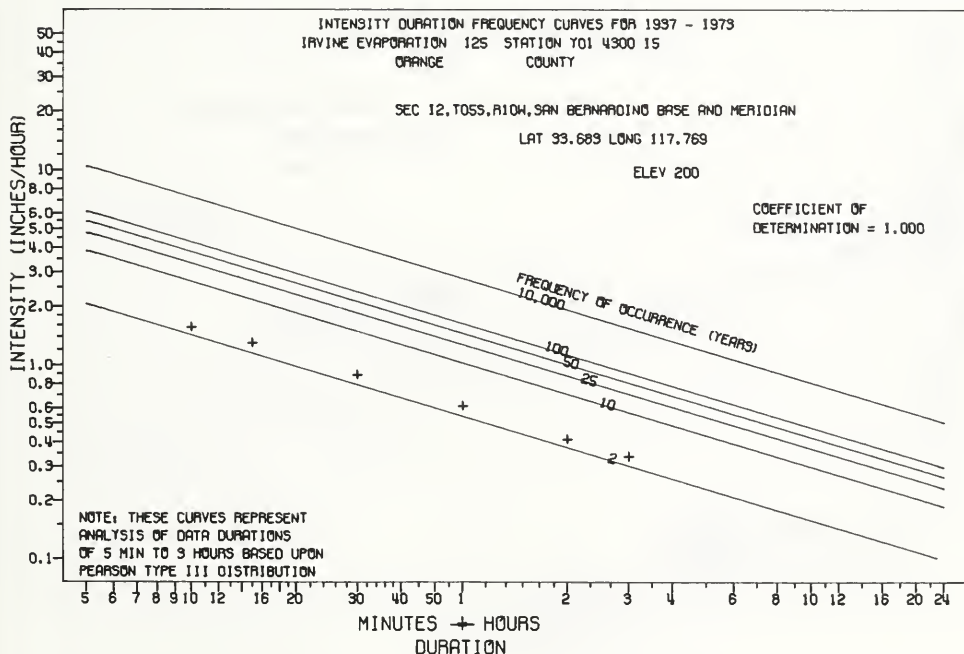
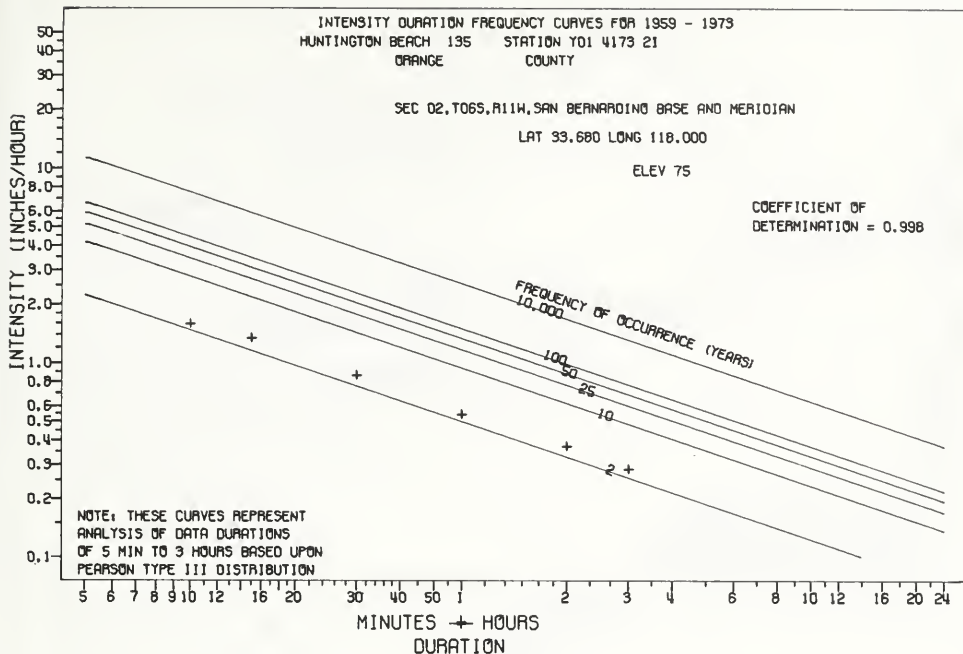




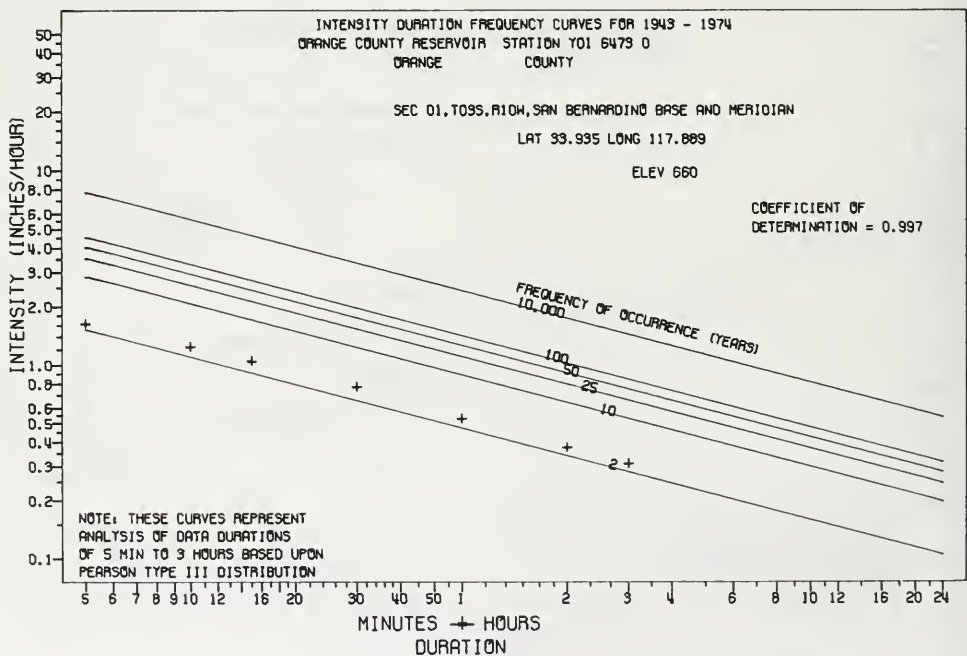
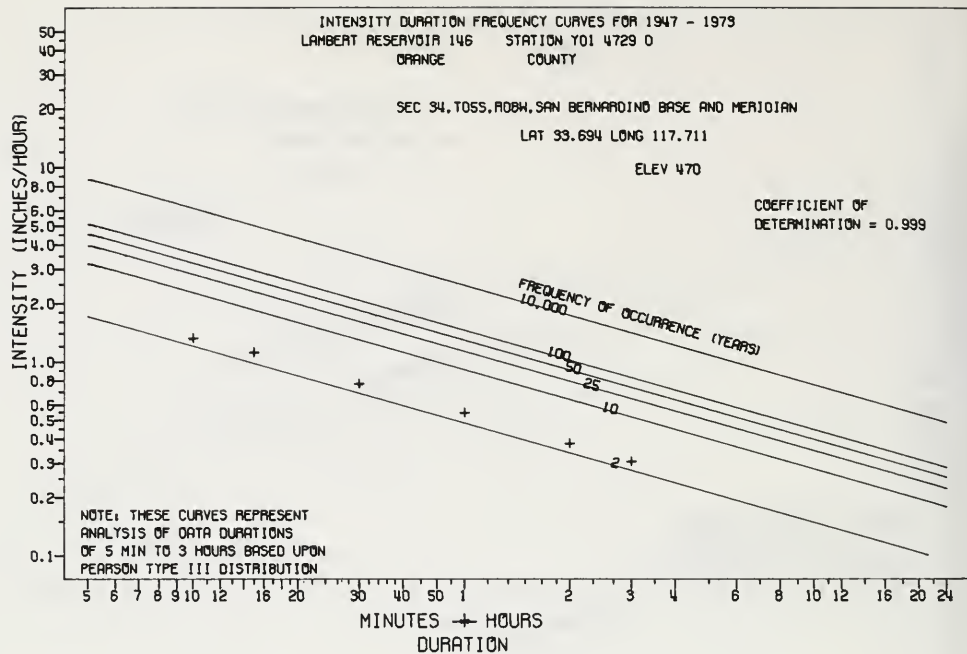




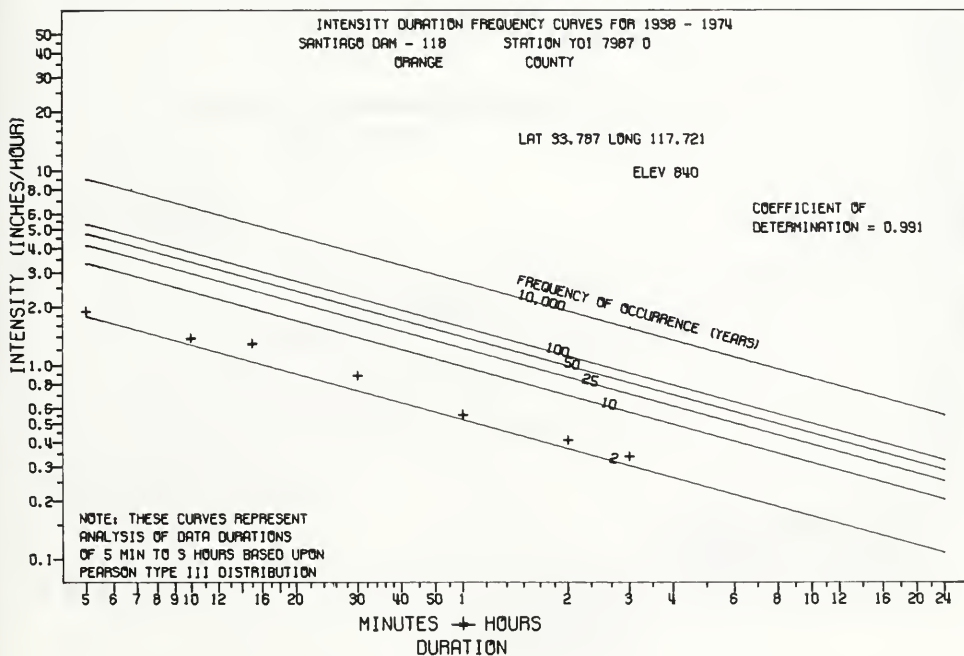
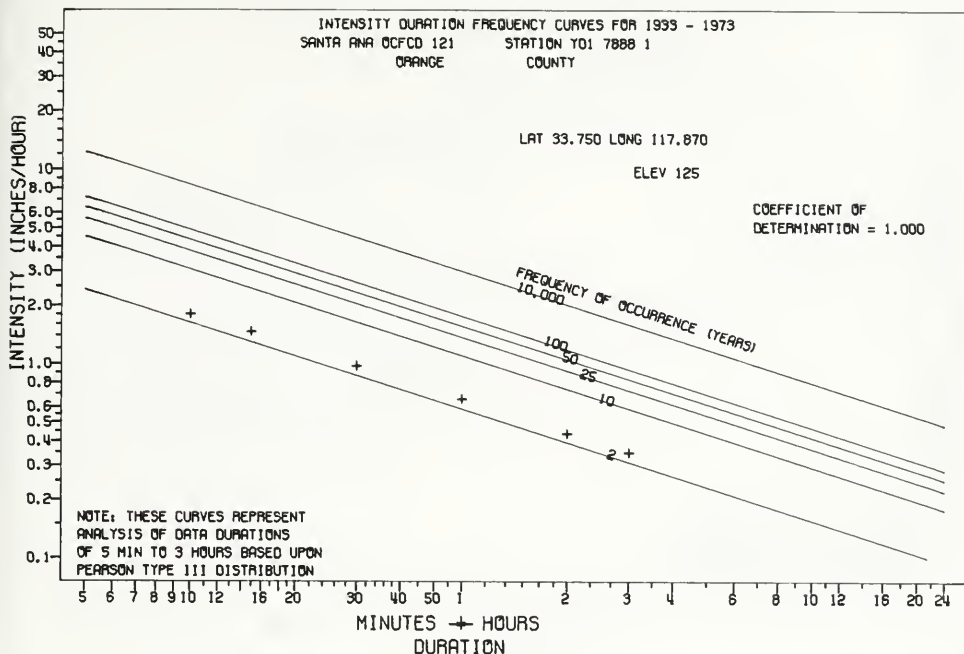


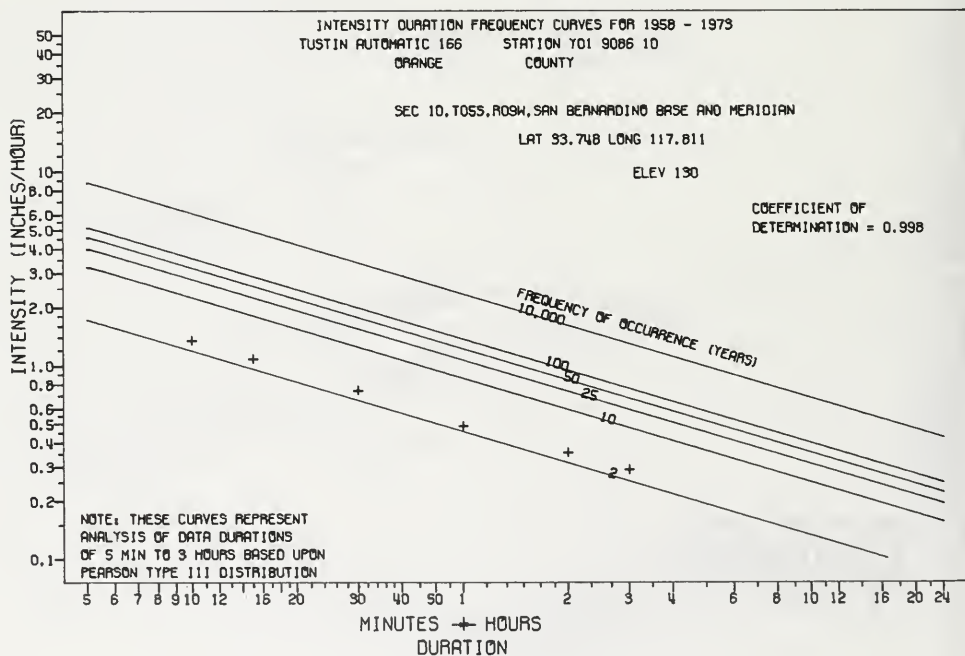
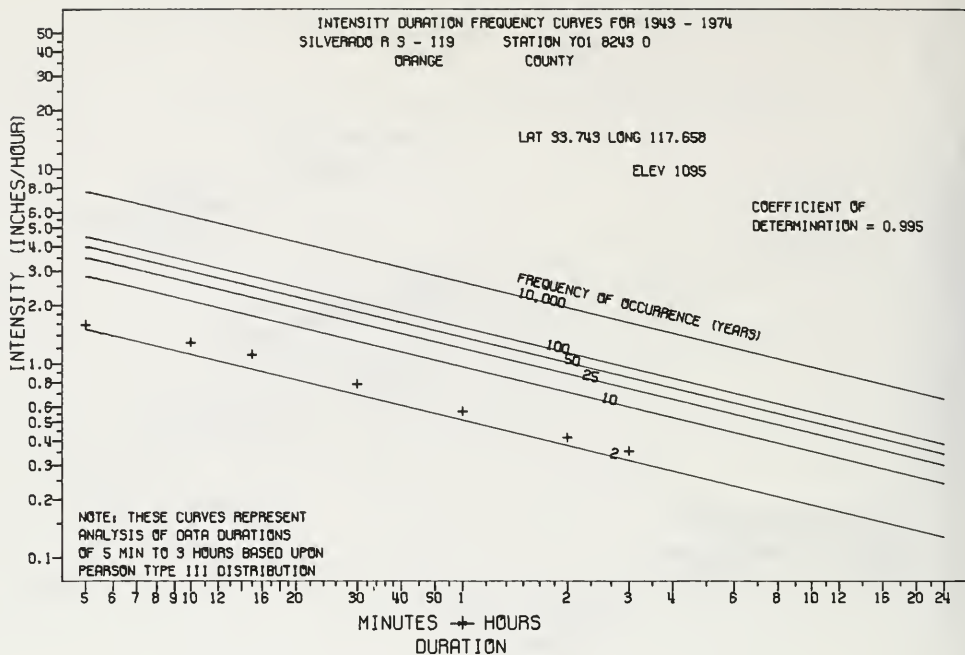


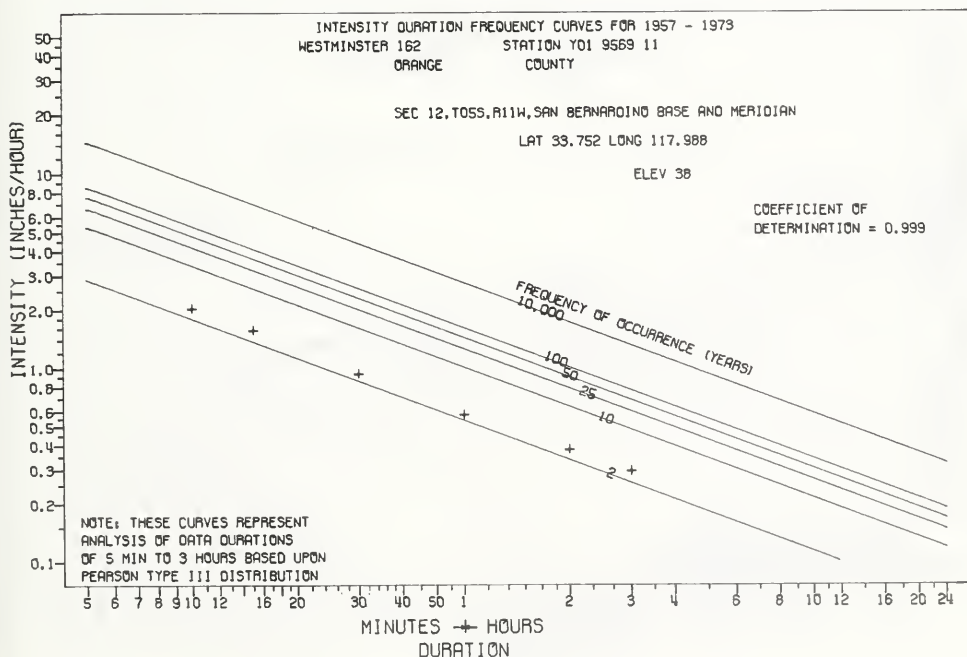
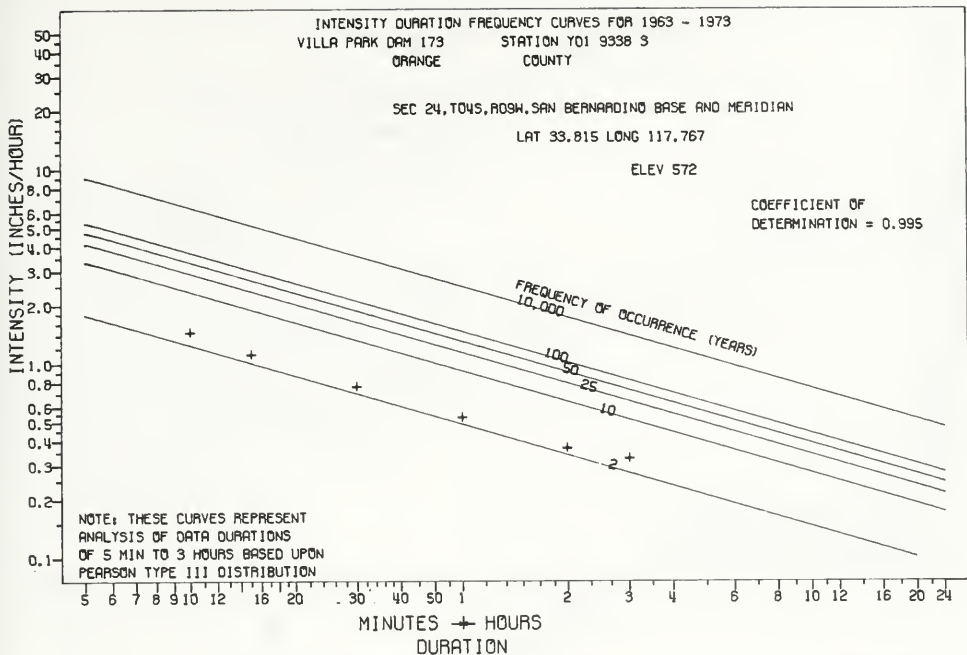


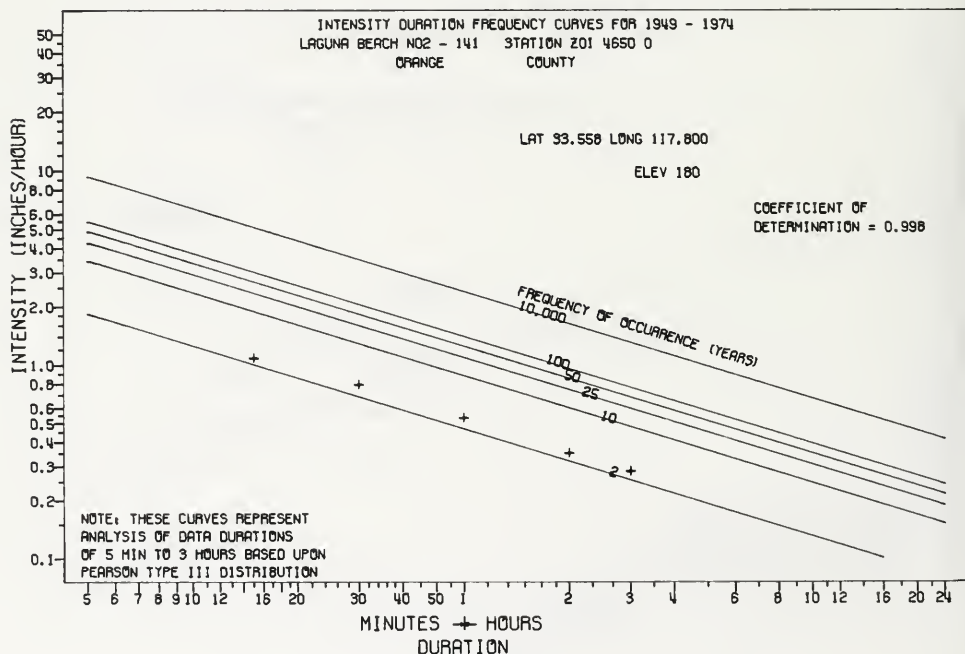
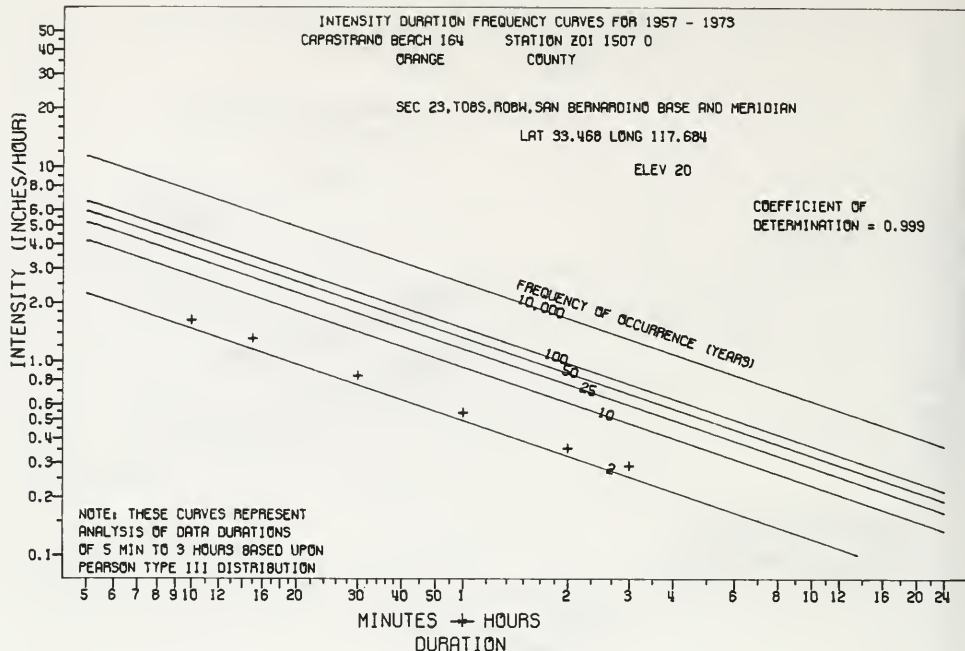












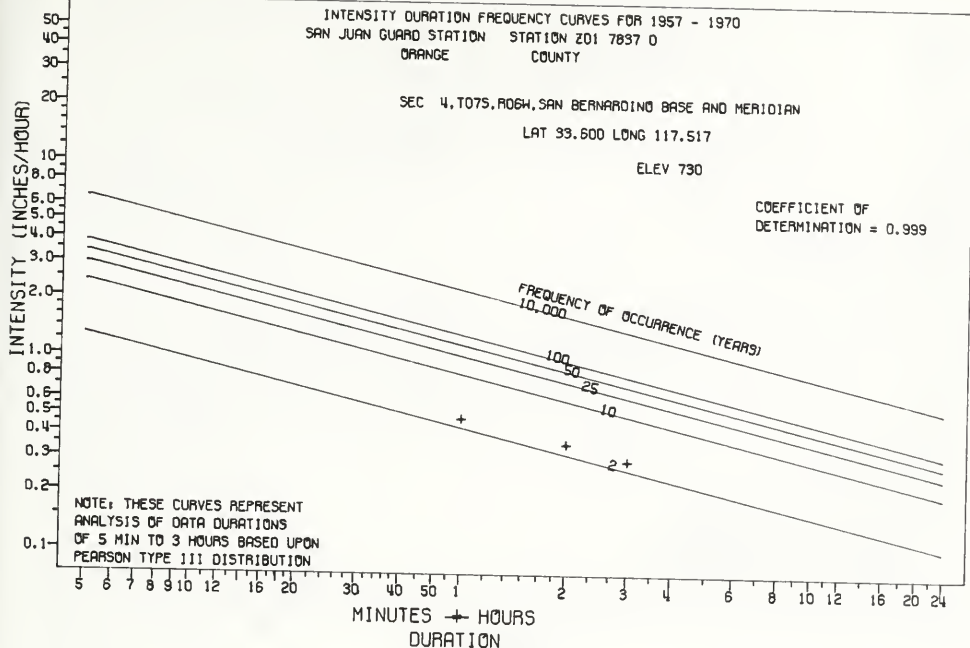
INTENSITY DURATION FREQUENCY CURVES FOR 1957 - 1970  
SAN JUAN GUARD STATION STATION 201 7837 0  
ORANGE COUNTY

SEC 4, T07S, R06W, SAN BERNARDINO BASE AND MERIDIAN

LAT 33.600 LONG 117.517

ELEV 730

COEFFICIENT OF  
DETERMINATION = 0.999

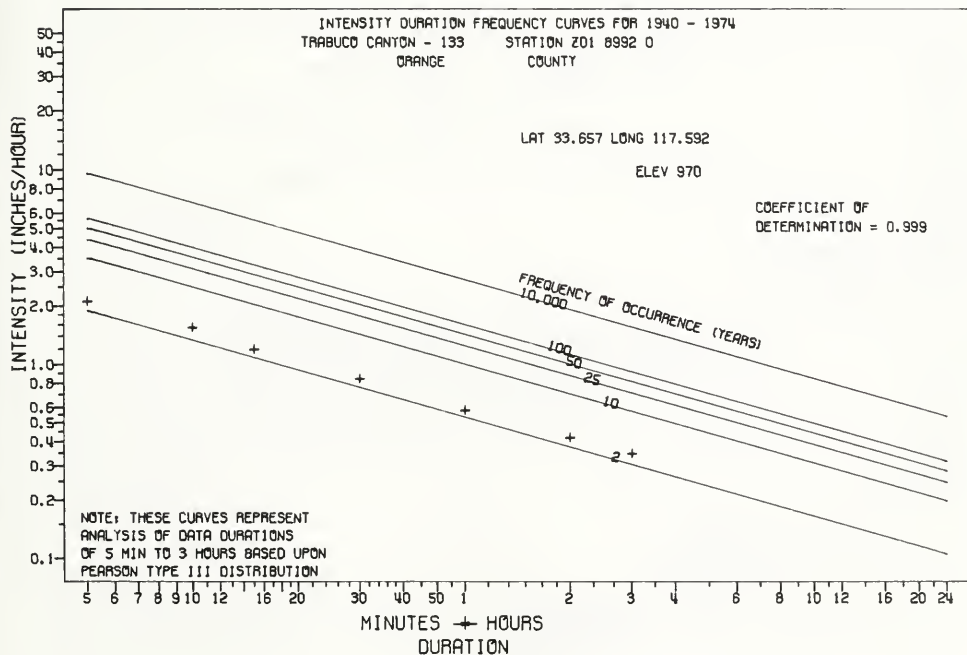


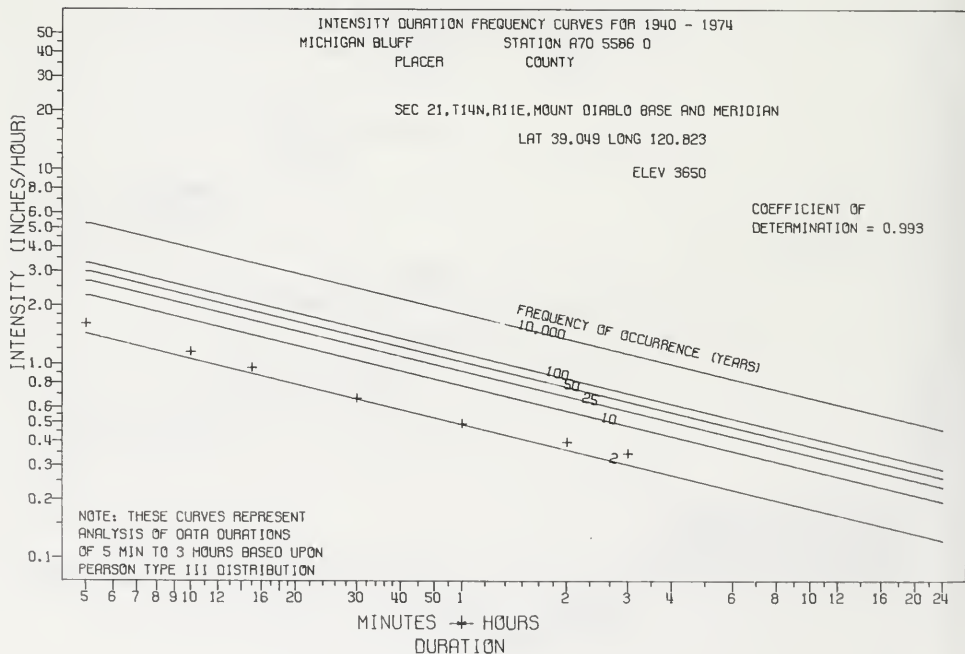
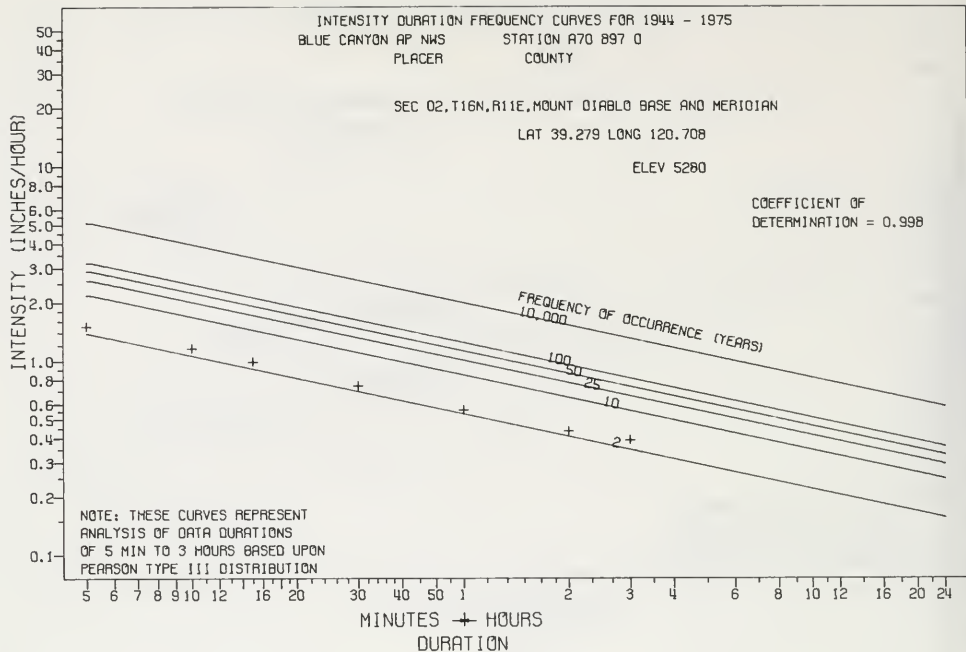
INTENSITY DURATION FREQUENCY CURVES FOR 1940 - 1974  
TRABUCO CANYON - 133 STATION 201 8992 0  
ORANGE COUNTY

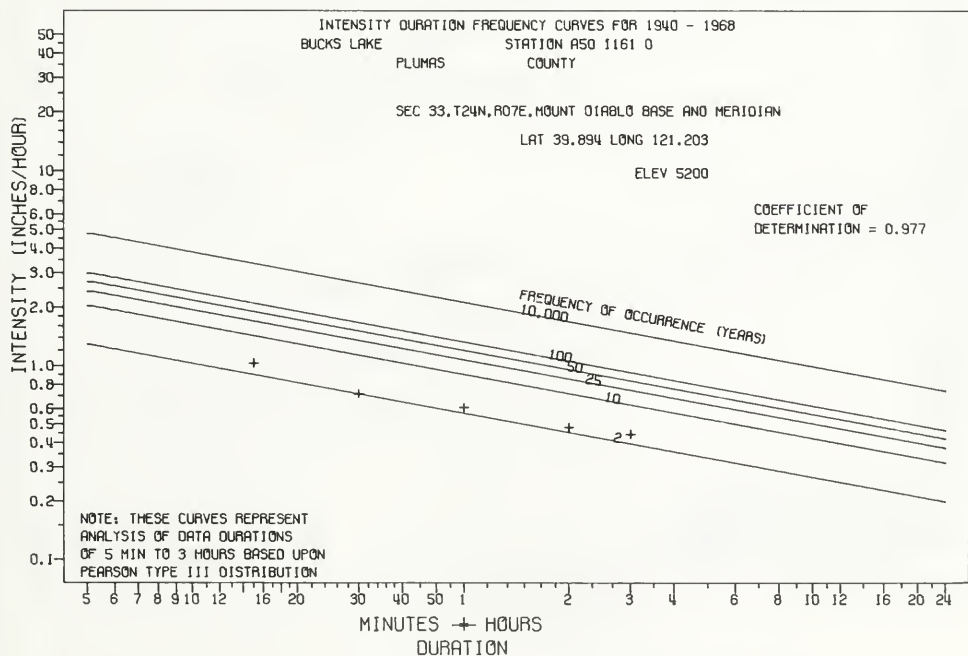
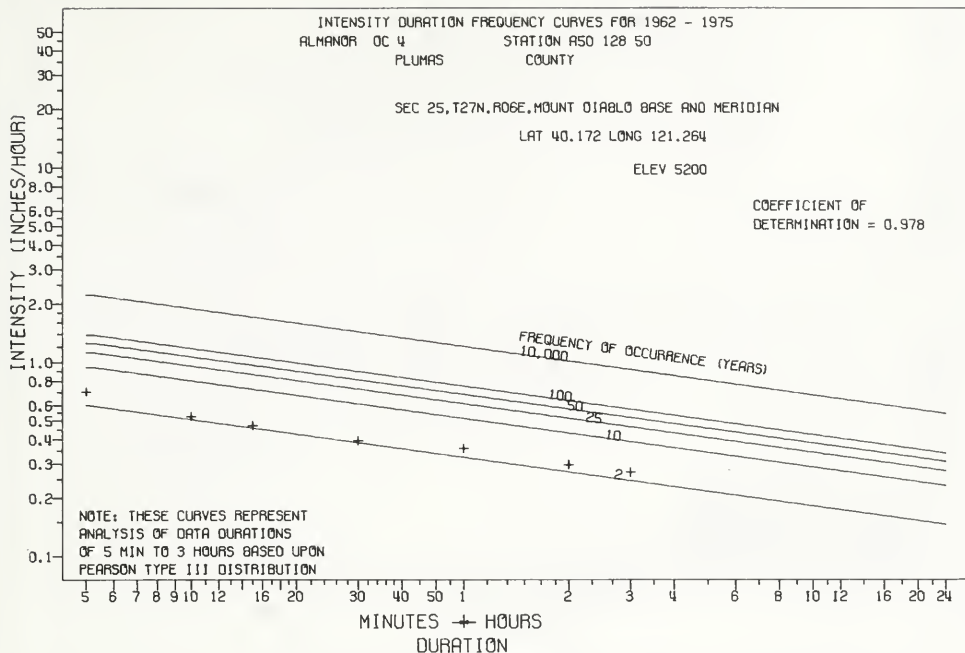
LAT 33.657 LONG 117.592

ELEV 970

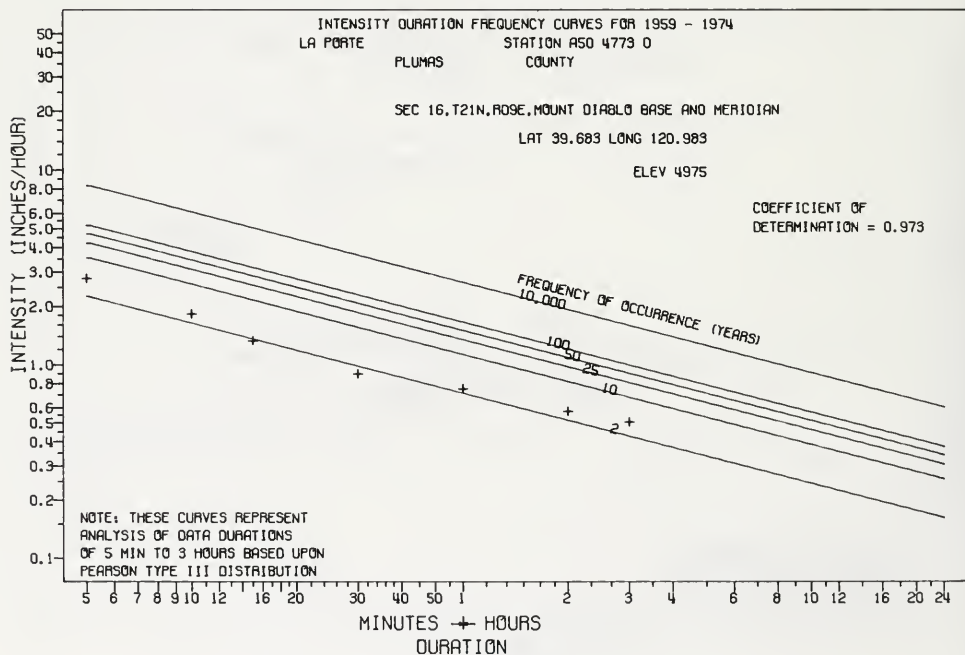
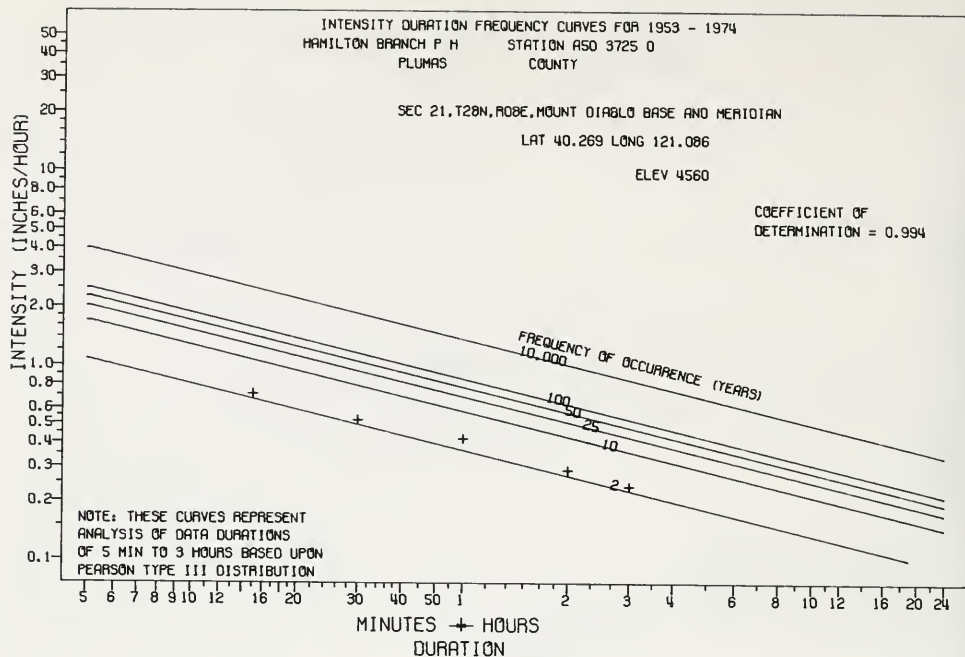
COEFFICIENT OF  
DETERMINATION = 0.999



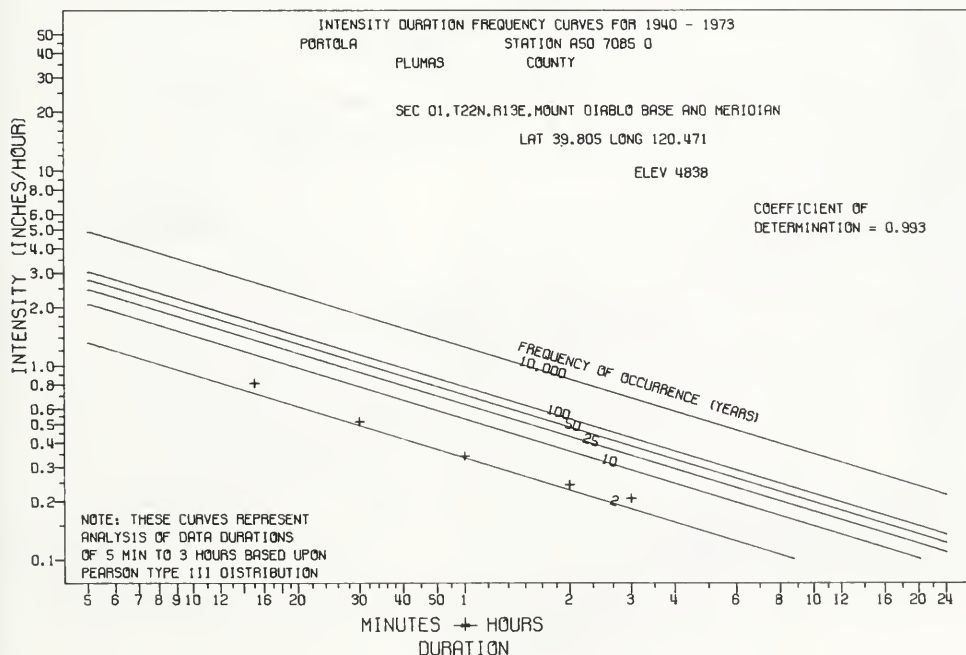
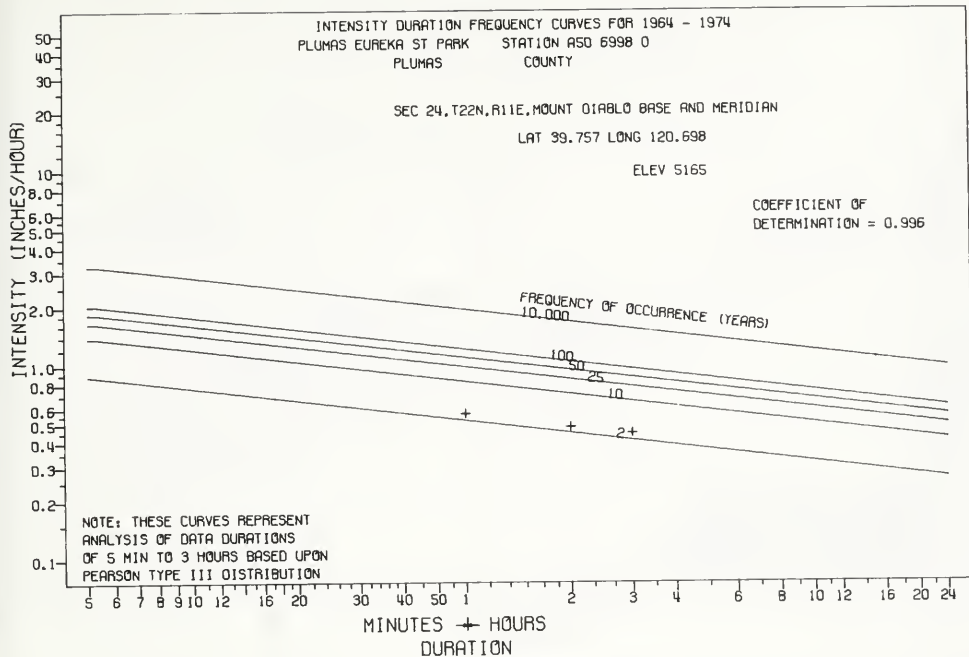


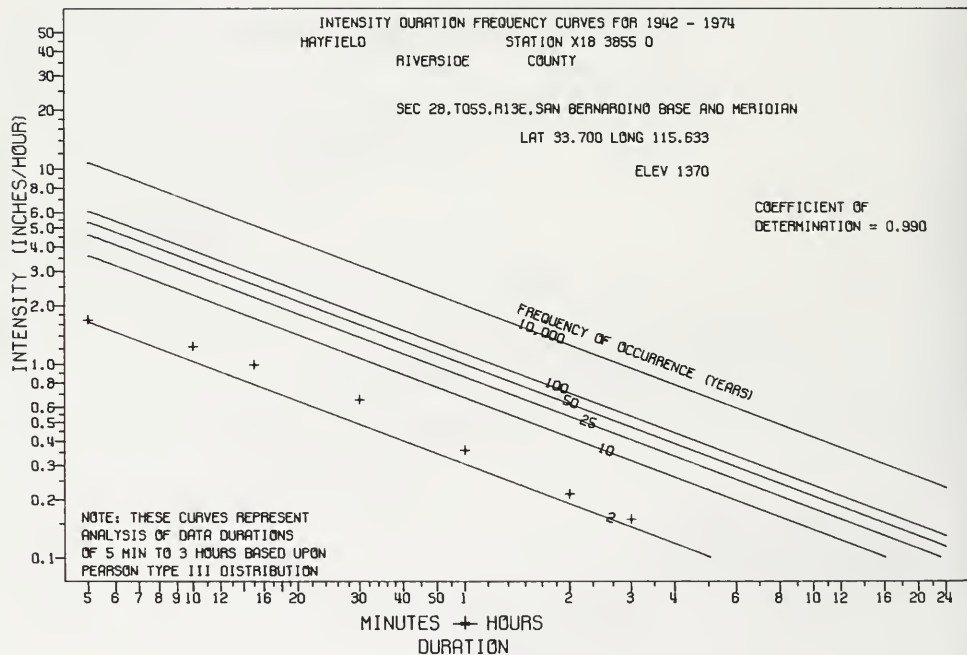
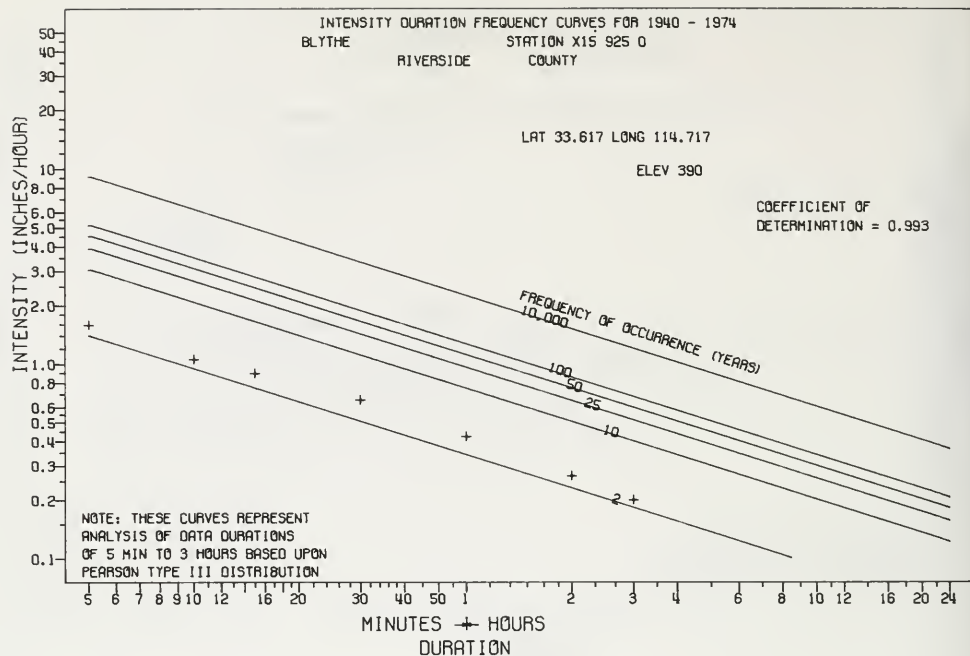












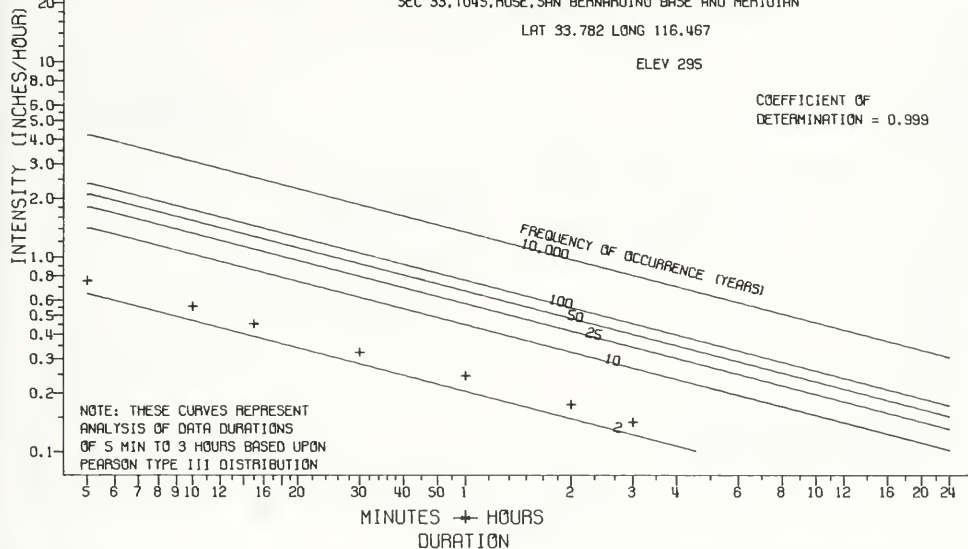
INTENSITY DURATION FREQUENCY CURVES FOR 1969 - 1975  
CATHEDRAL CITY A O STATION X19 1594 0  
RIVERSIDE COUNTY

SEC 33, T04S, R05E, SAN BERNARDINO BASE AND MERIDIAN

LAT 33.782 LONG 116.467

ELEV 295

COEFFICIENT OF  
DETERMINATION = 0.999



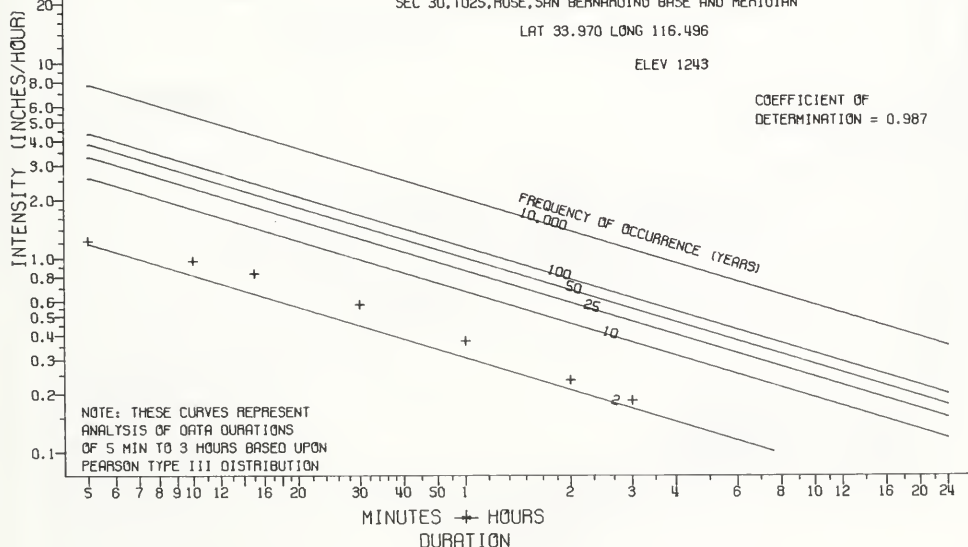
INTENSITY DURATION FREQUENCY CURVES FOR 1958 - 1975  
DESERT HOT SPRINGS STATION X19 2405 0  
RIVERSIDE COUNTY

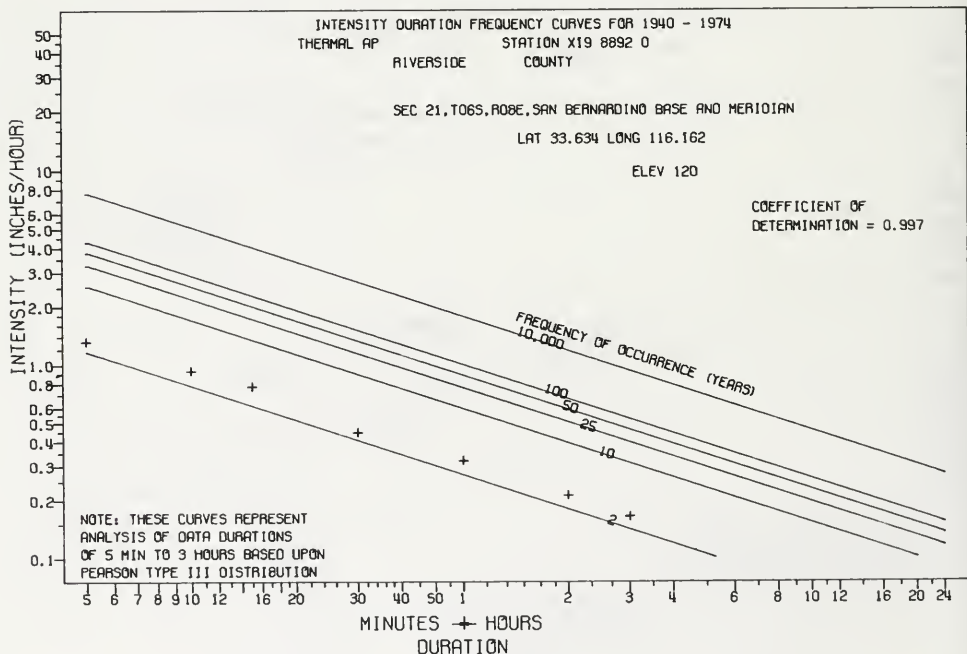
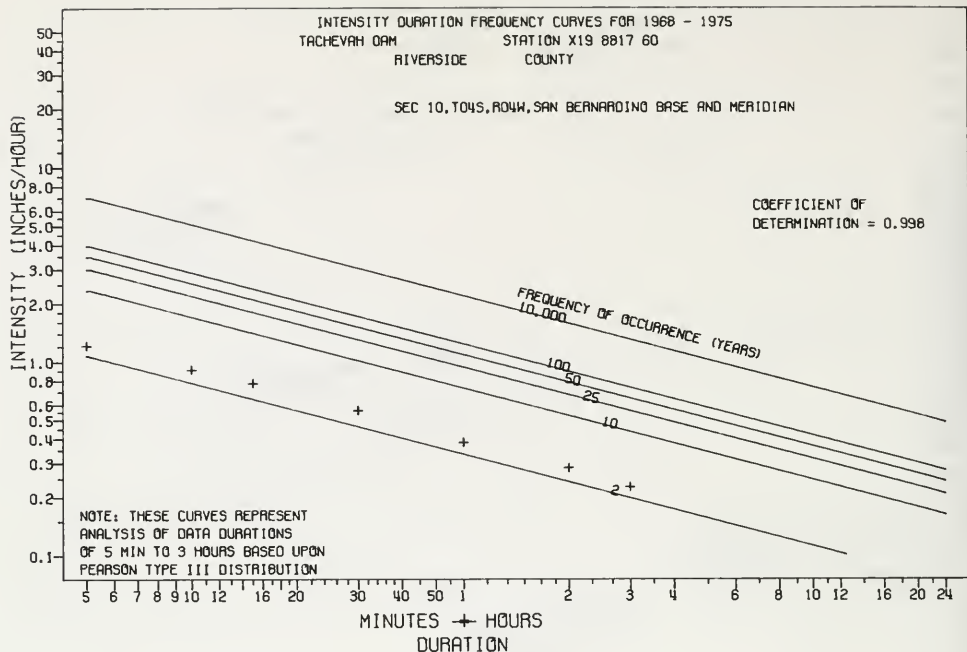
SEC 30, T02S, R05E, SAN BERNARDINO BASE AND MERIDIAN

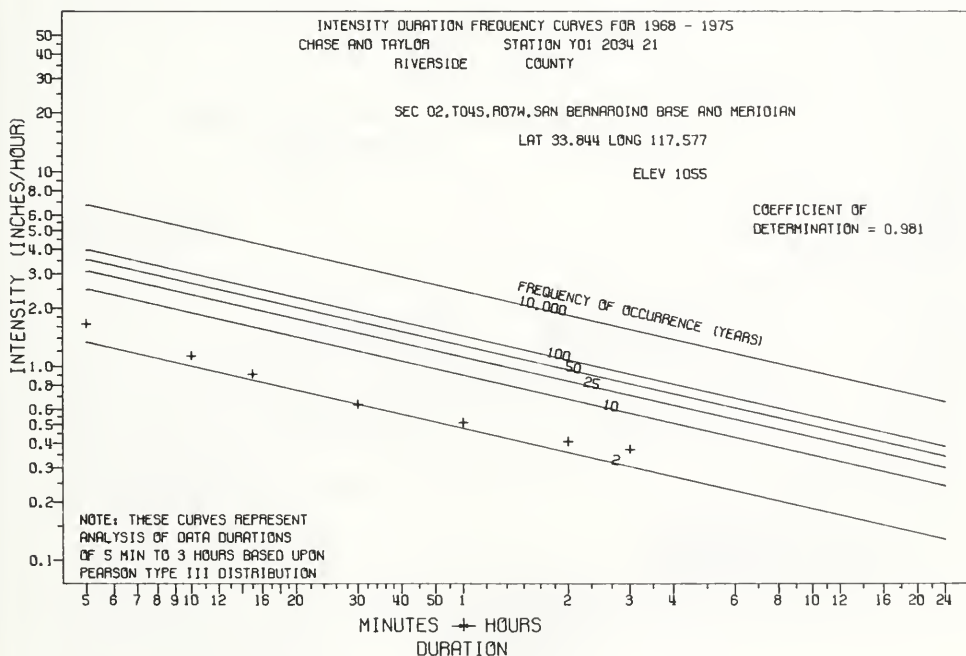
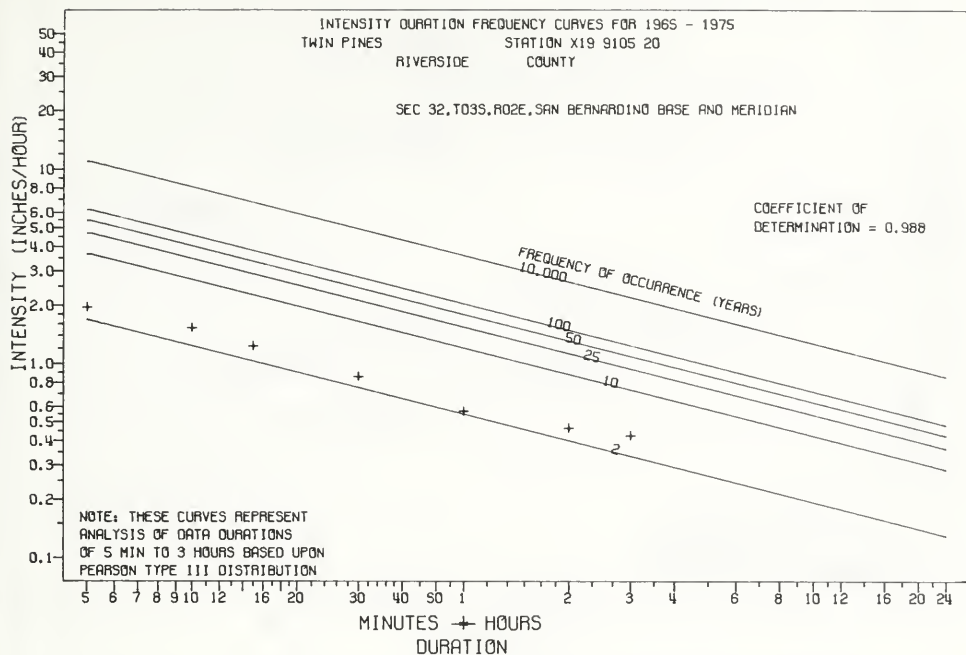
LAT 33.970 LONG 116.496

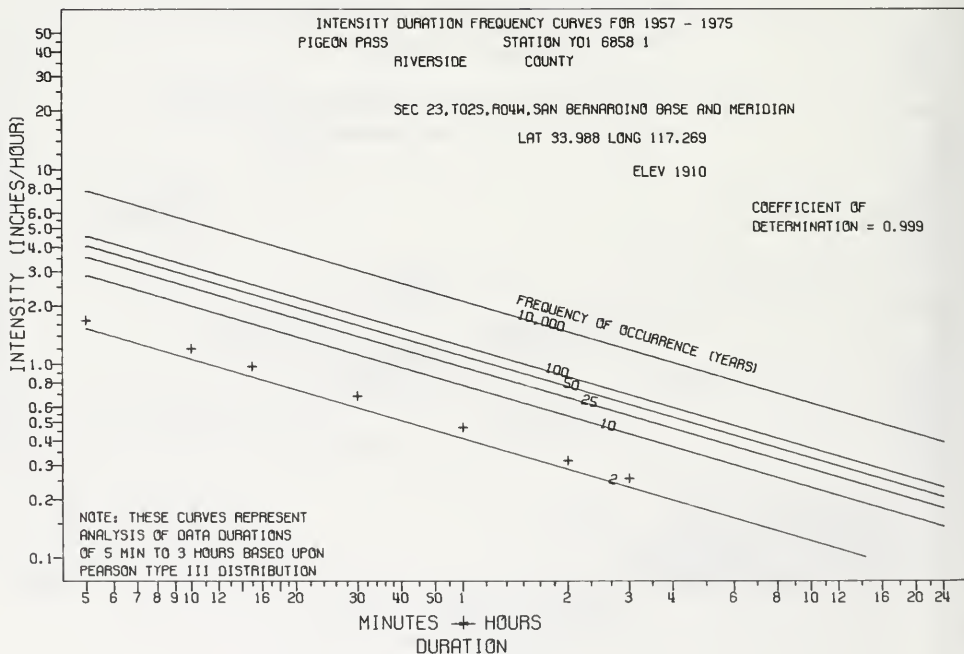
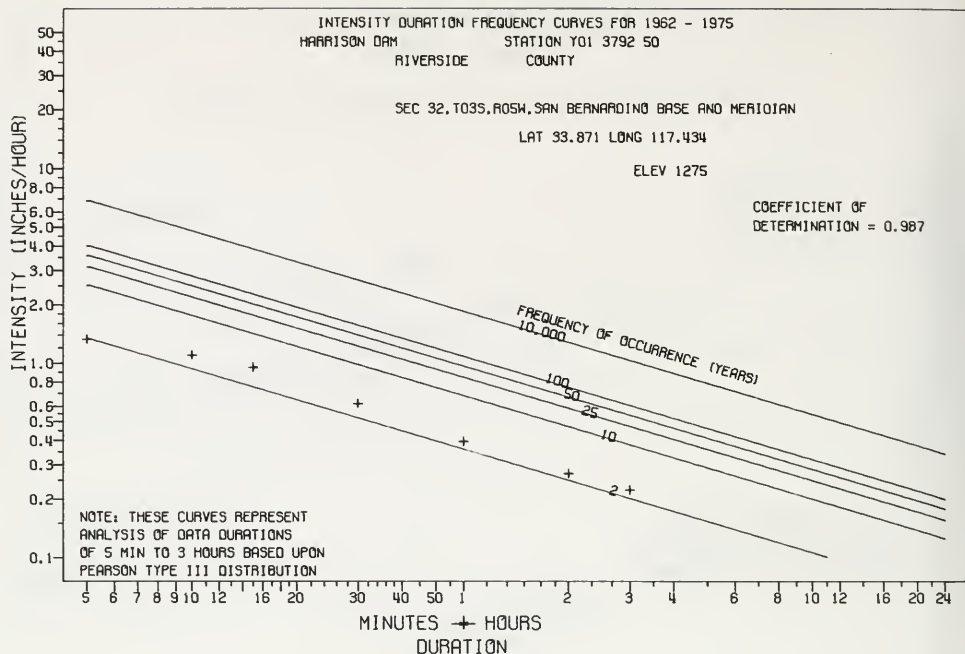
ELEV 1243

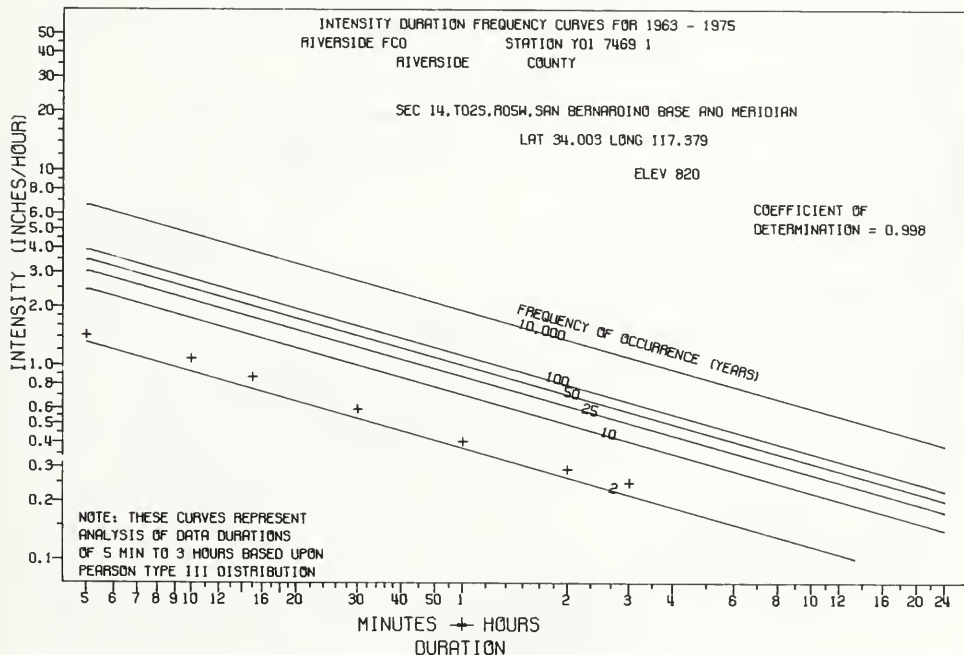
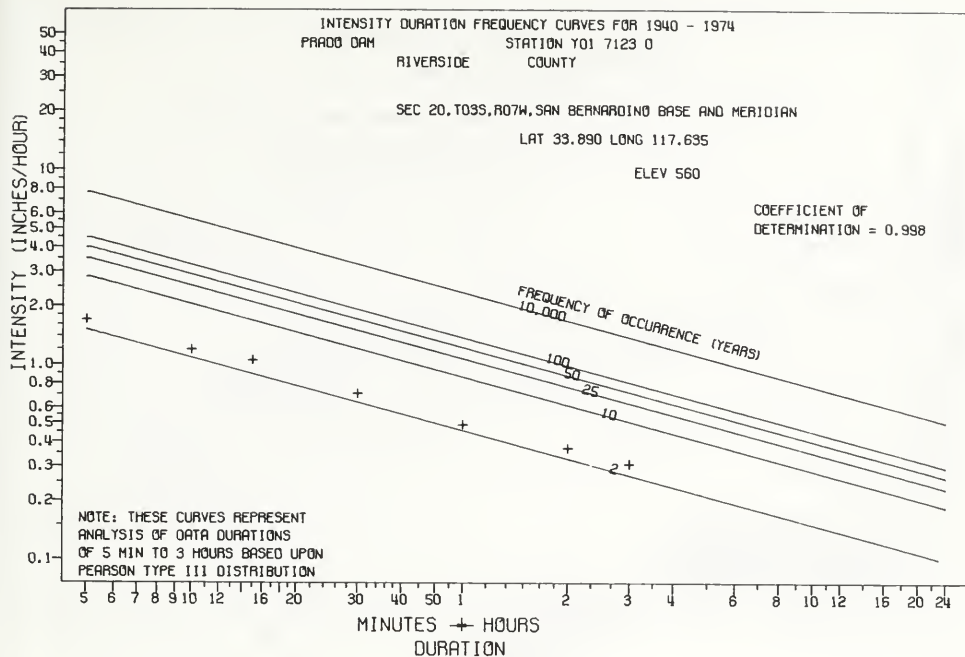
COEFFICIENT OF  
DETERMINATION = 0.987



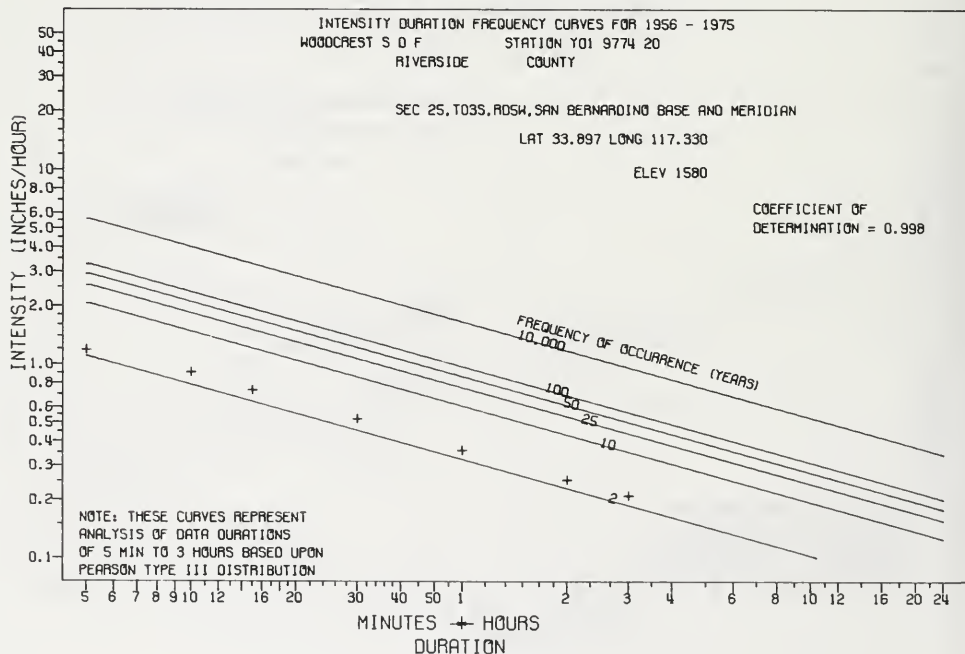
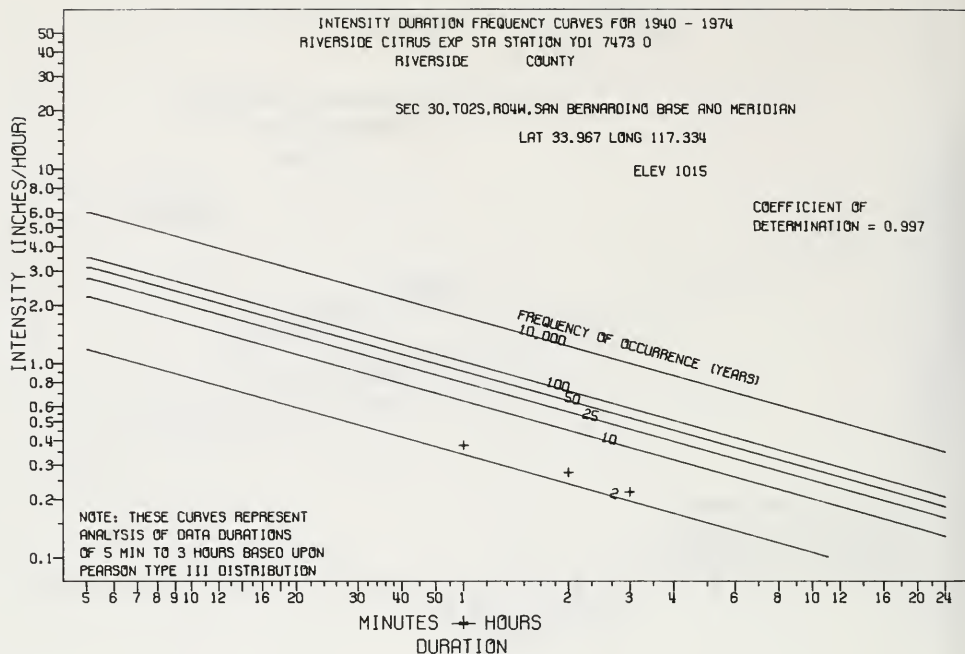




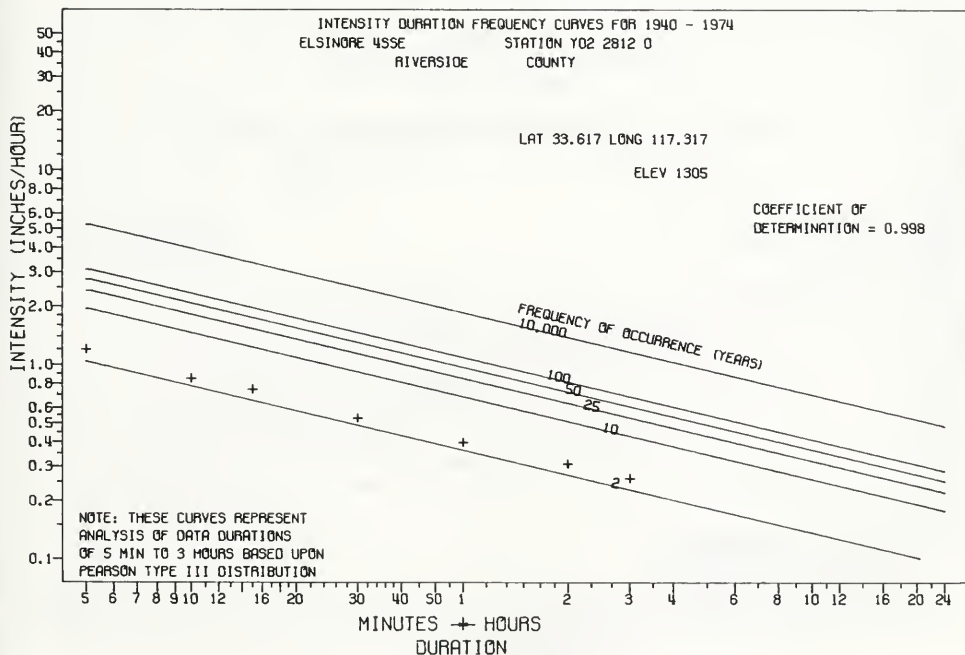
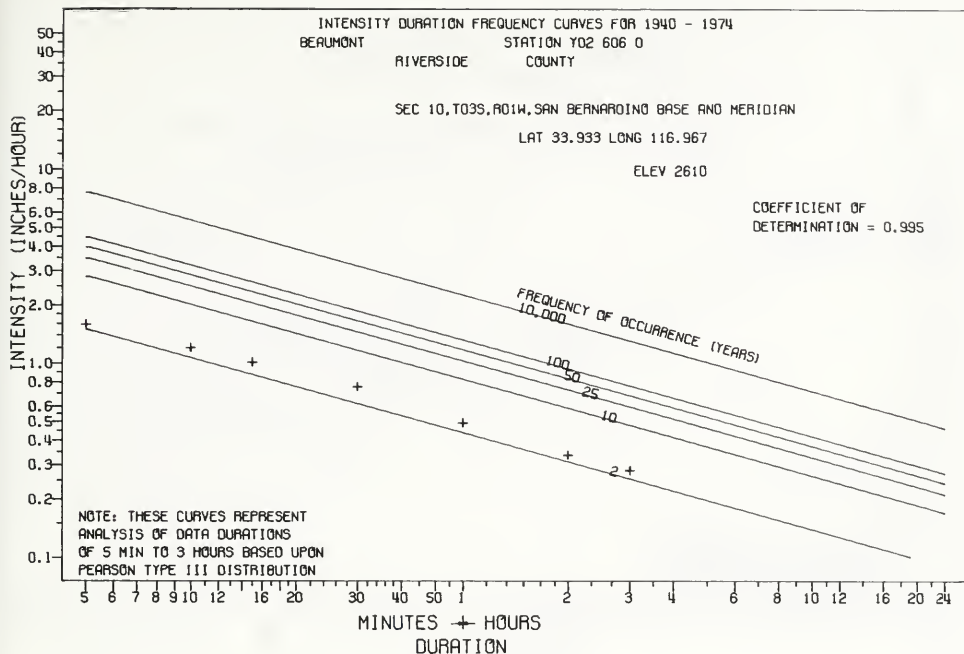


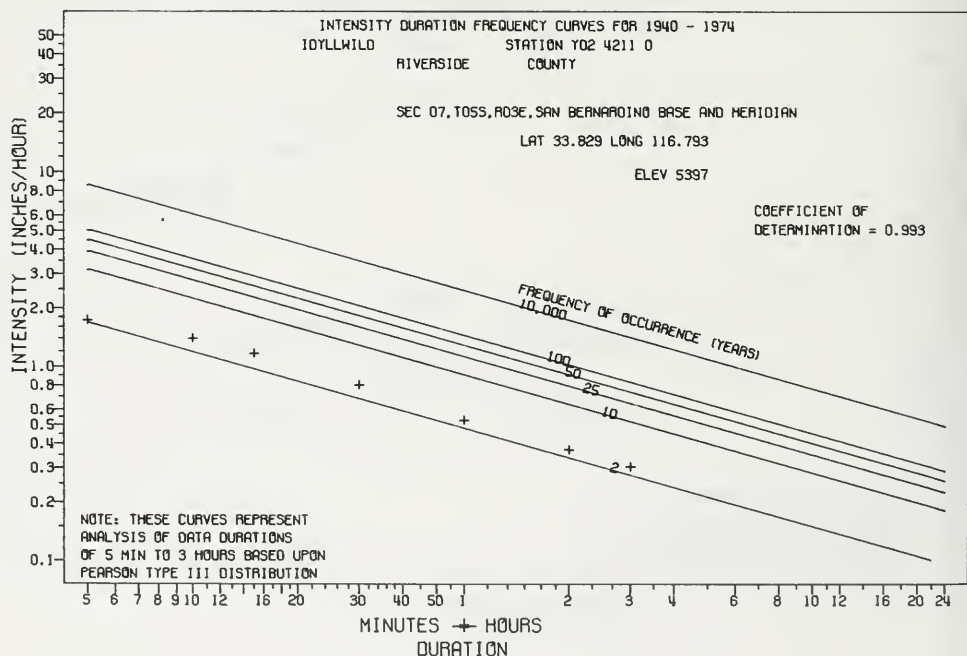
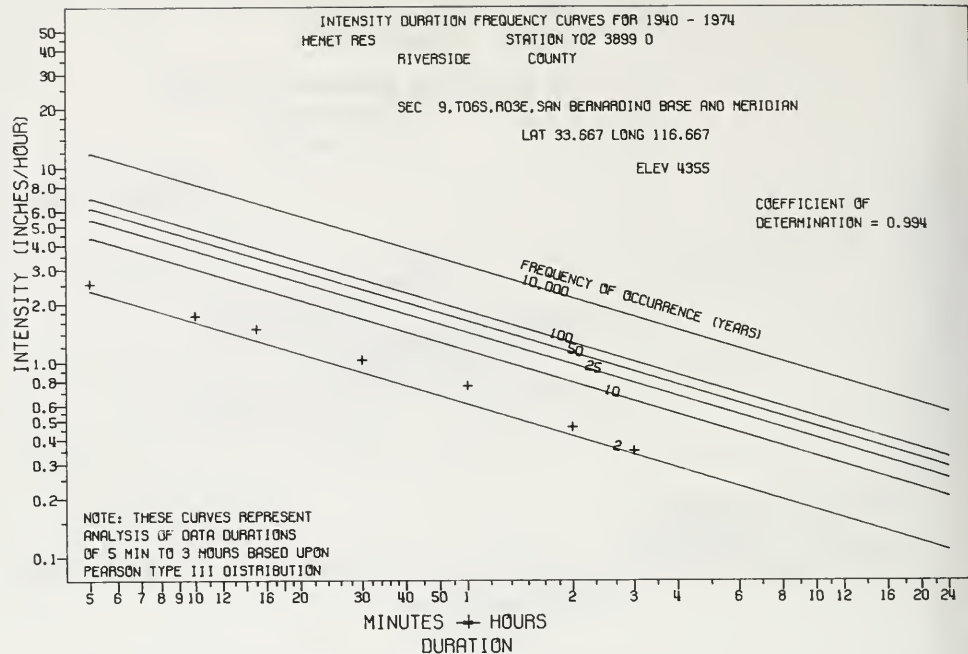


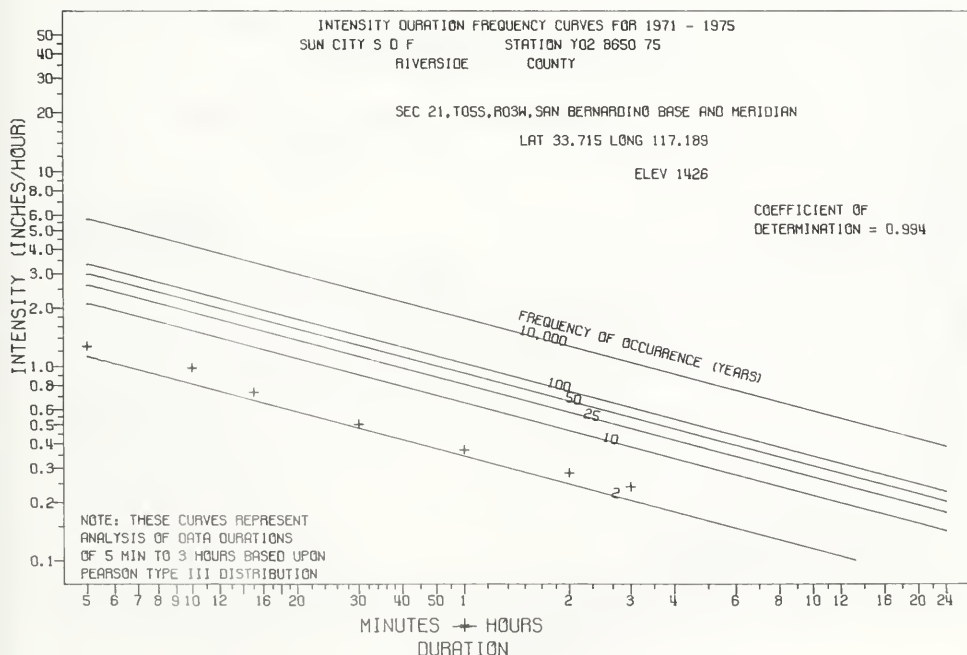
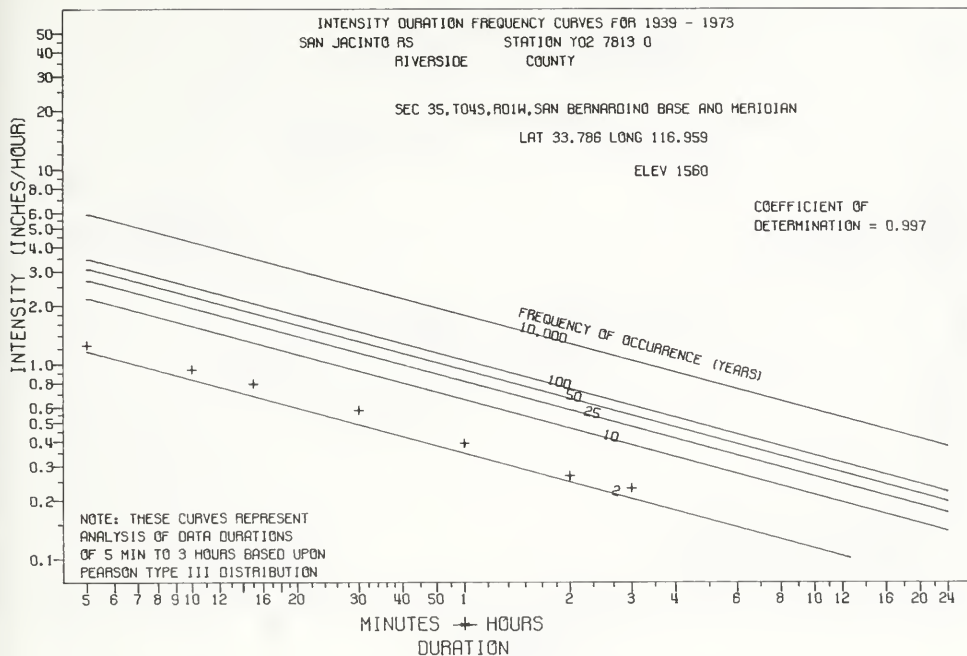


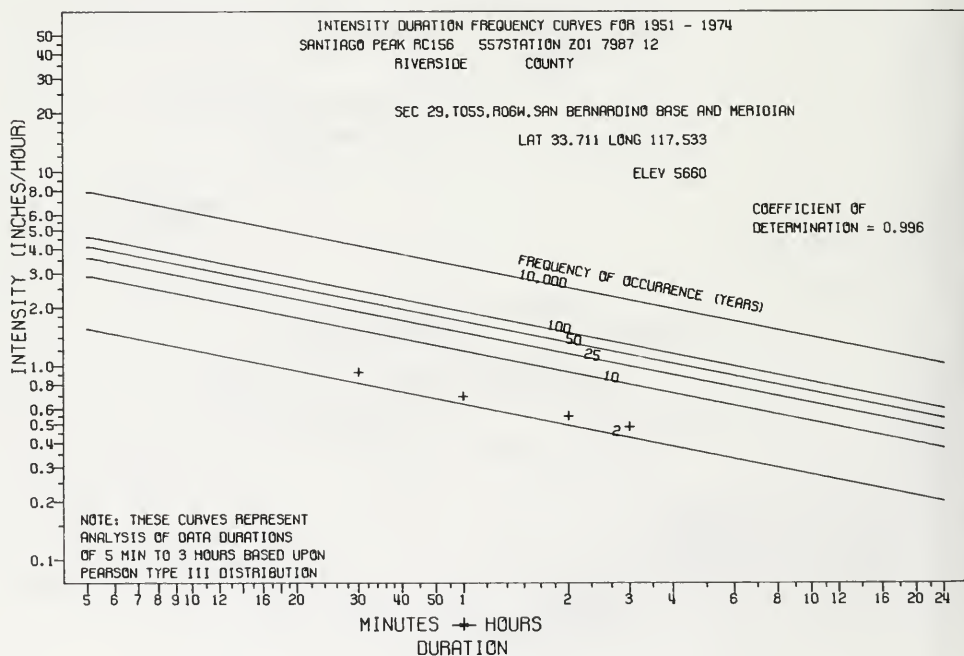
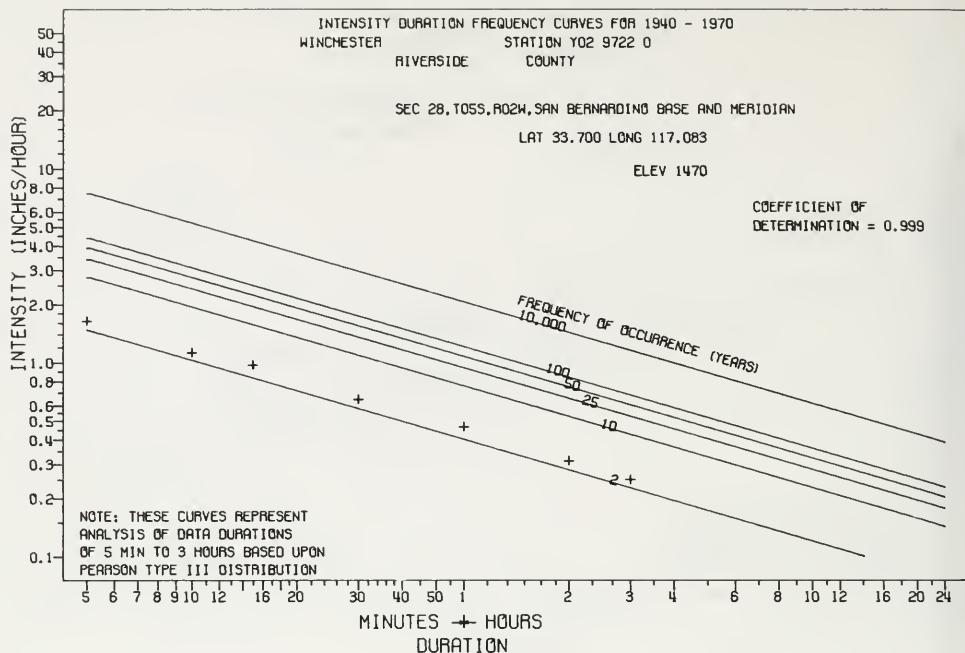


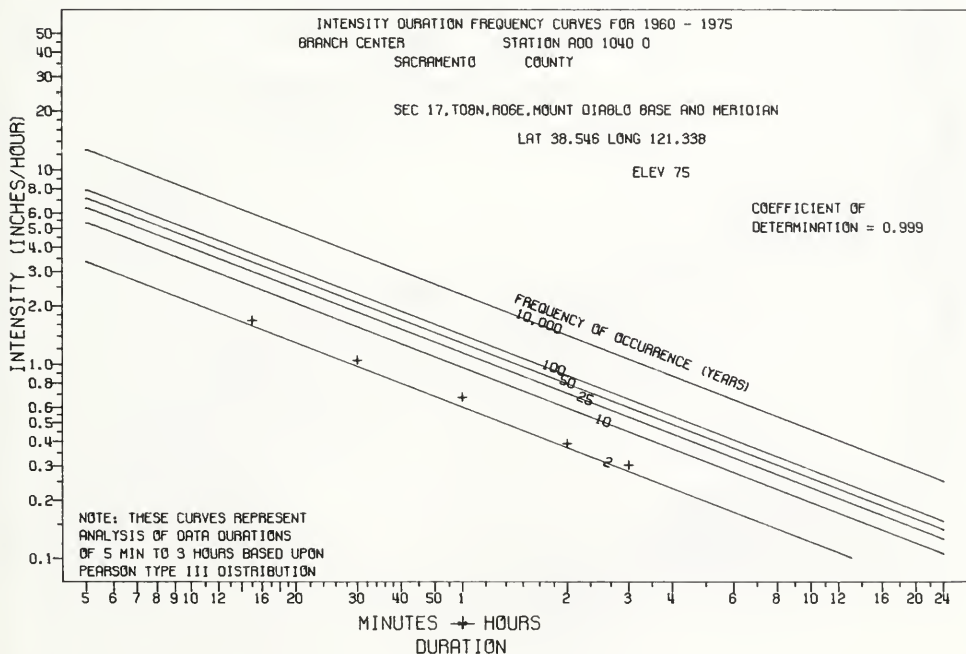
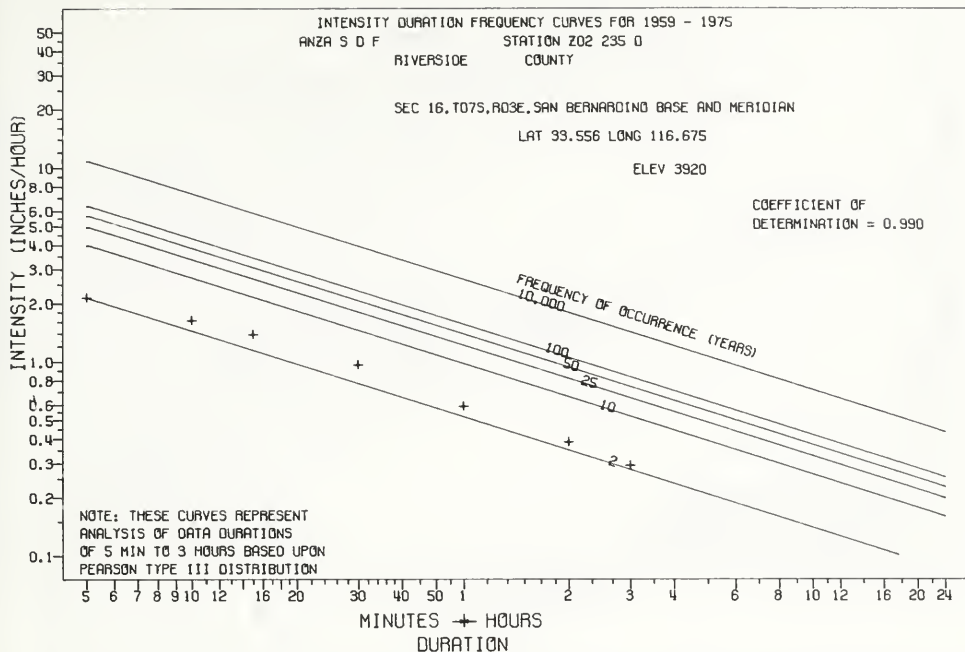


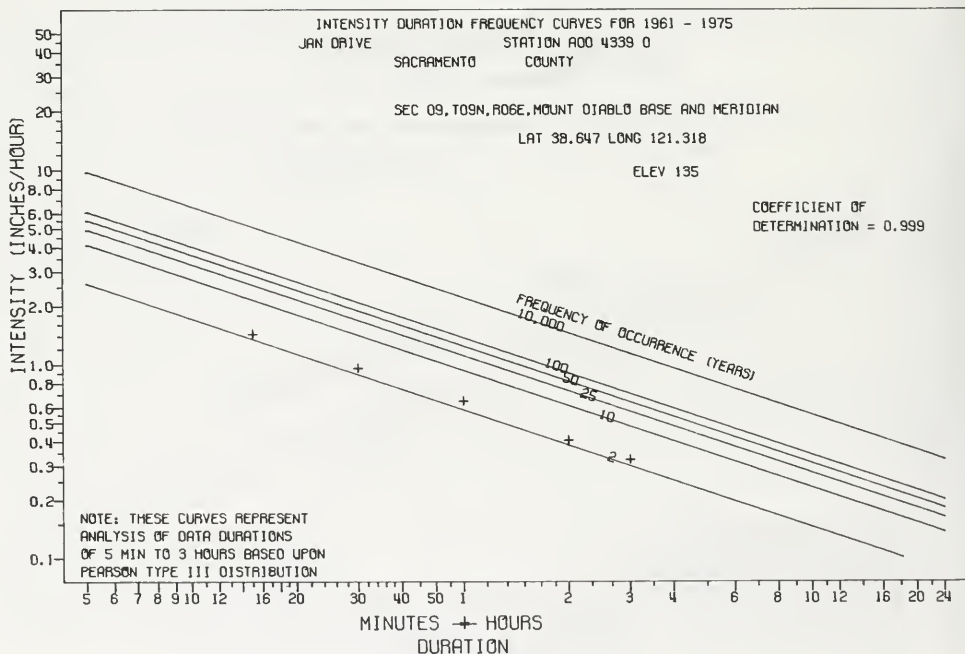
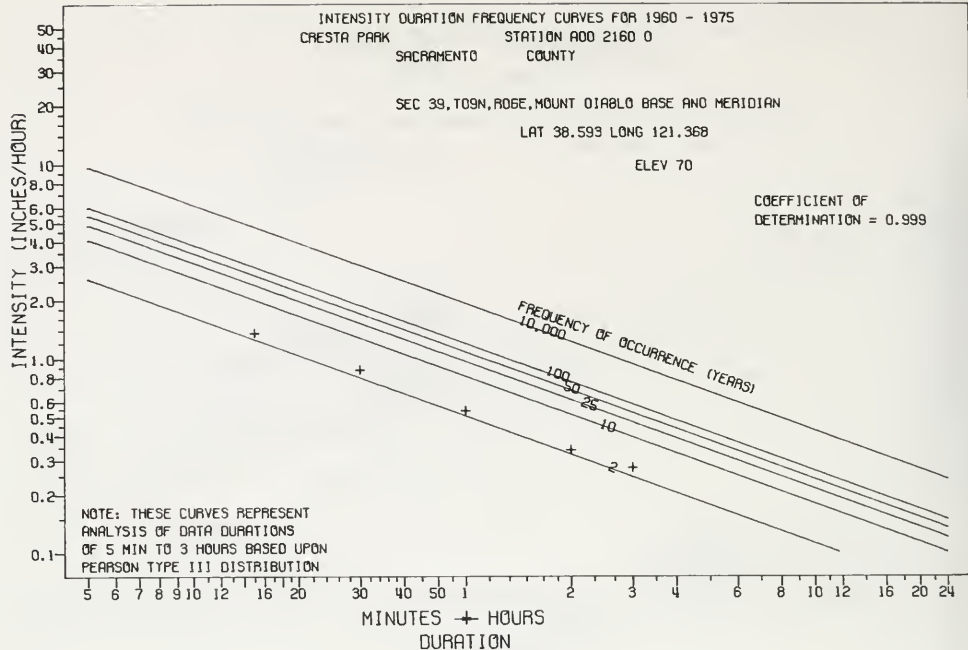


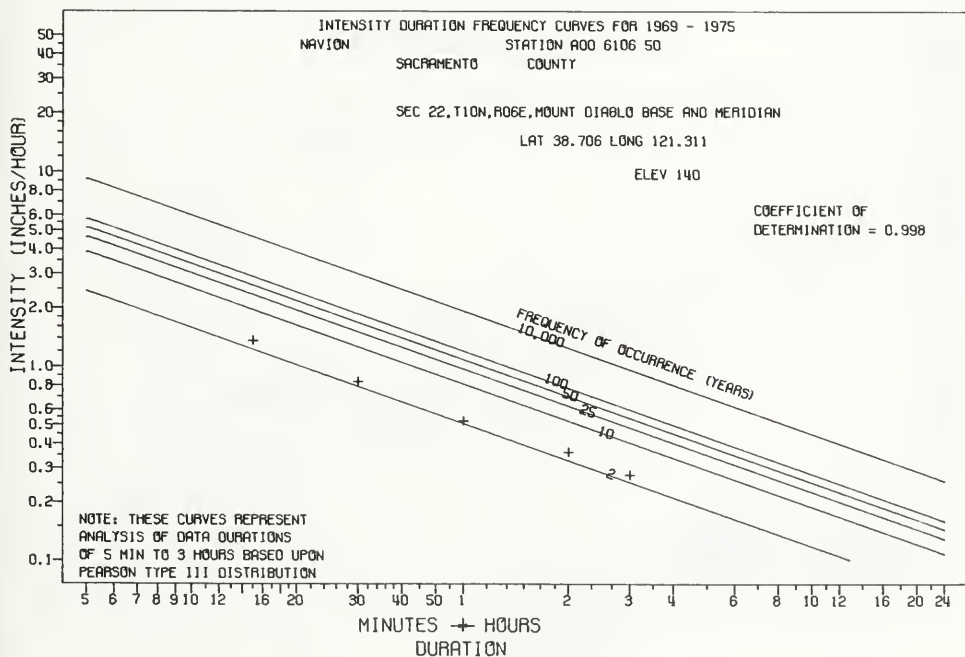
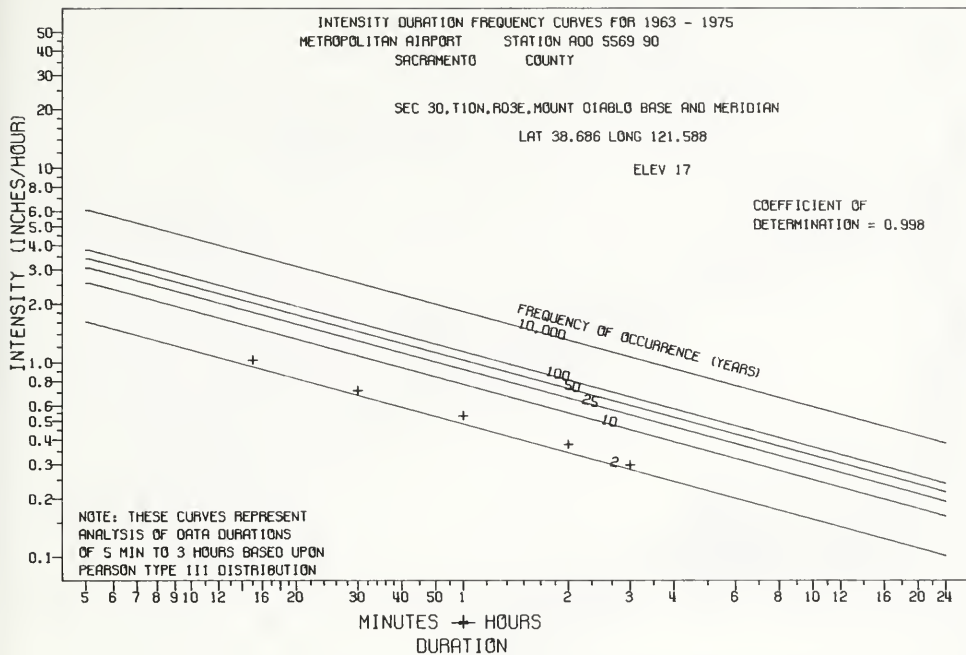




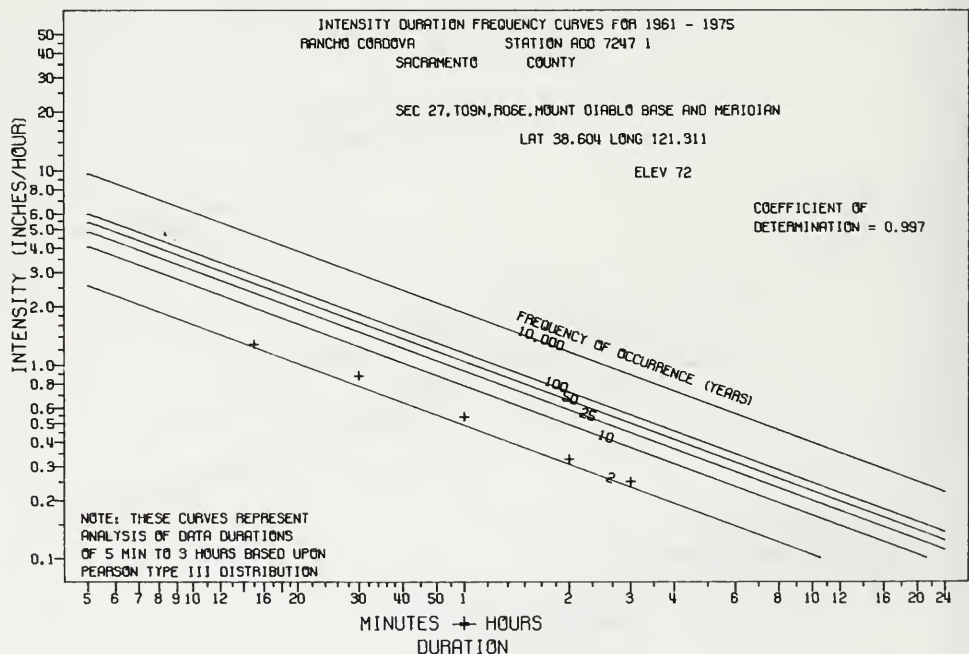
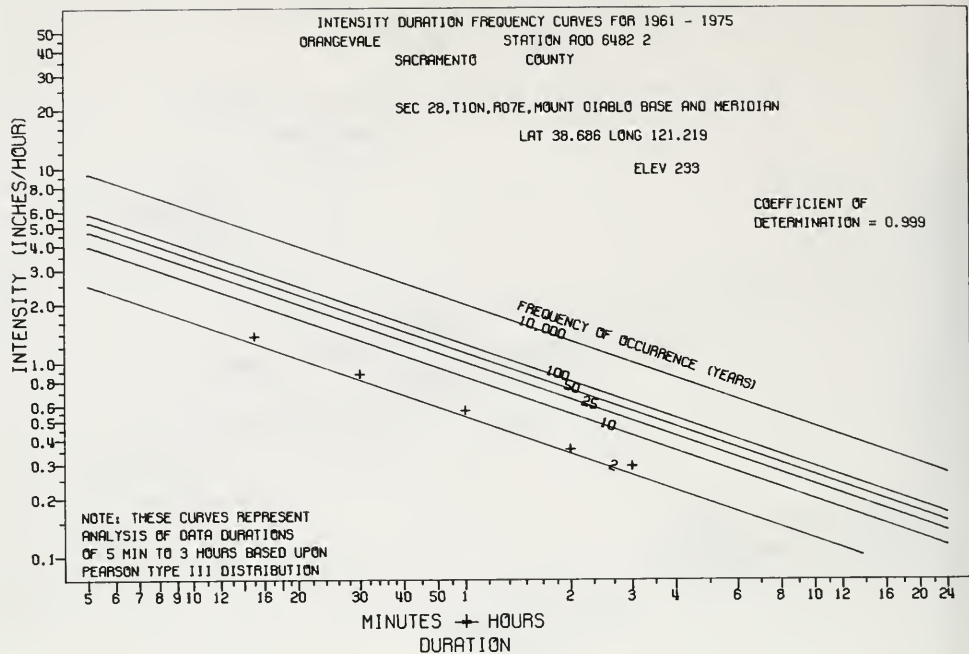










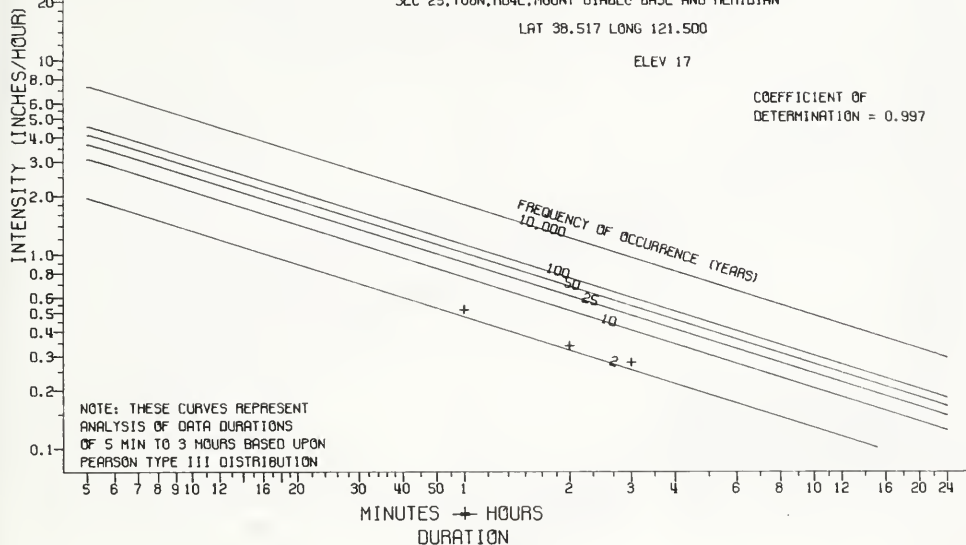




INTENSITY DURATION FREQUENCY CURVES FOR 1940 - 1974  
SACRAMENTO AP STATION AOD 7630 0  
SACRAMENTO COUNTY

SEC 25, T08N, R04E, MOUNT DIABLO BASE AND MERIDIAN  
LAT 38.517 LONG 121.500  
ELEV 17

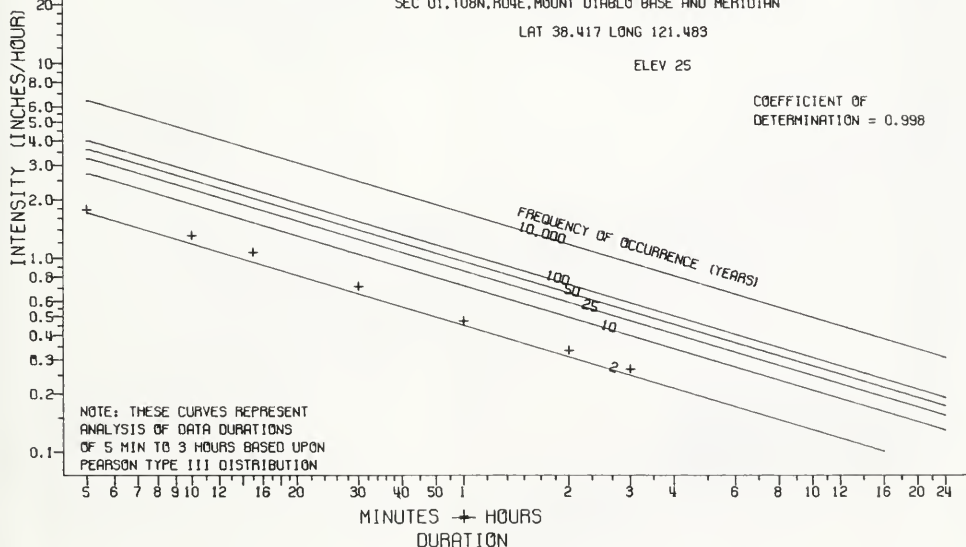
COEFFICIENT OF  
DETERMINATION = 0.997

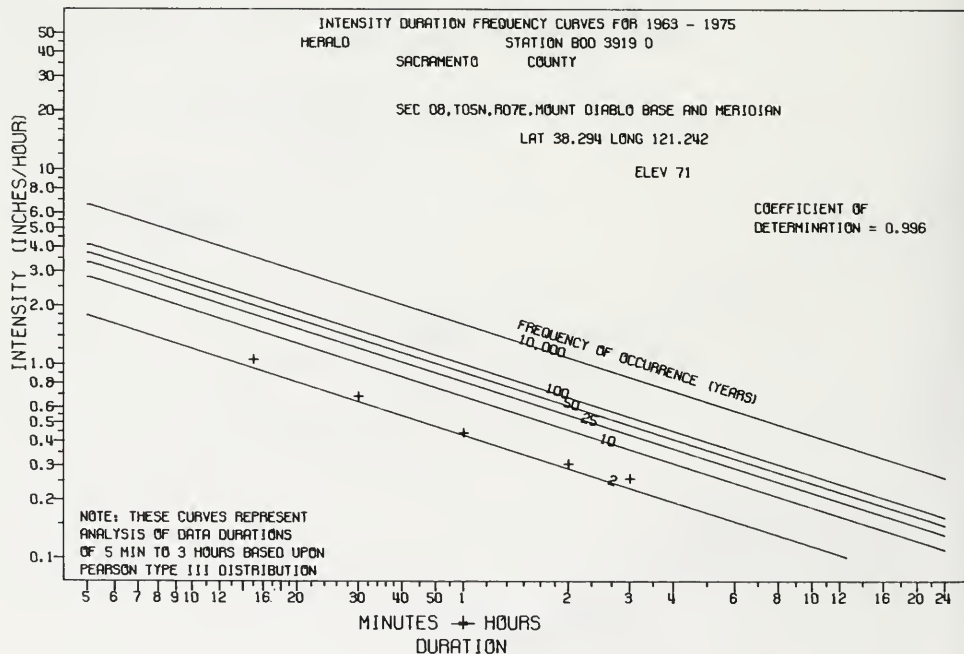
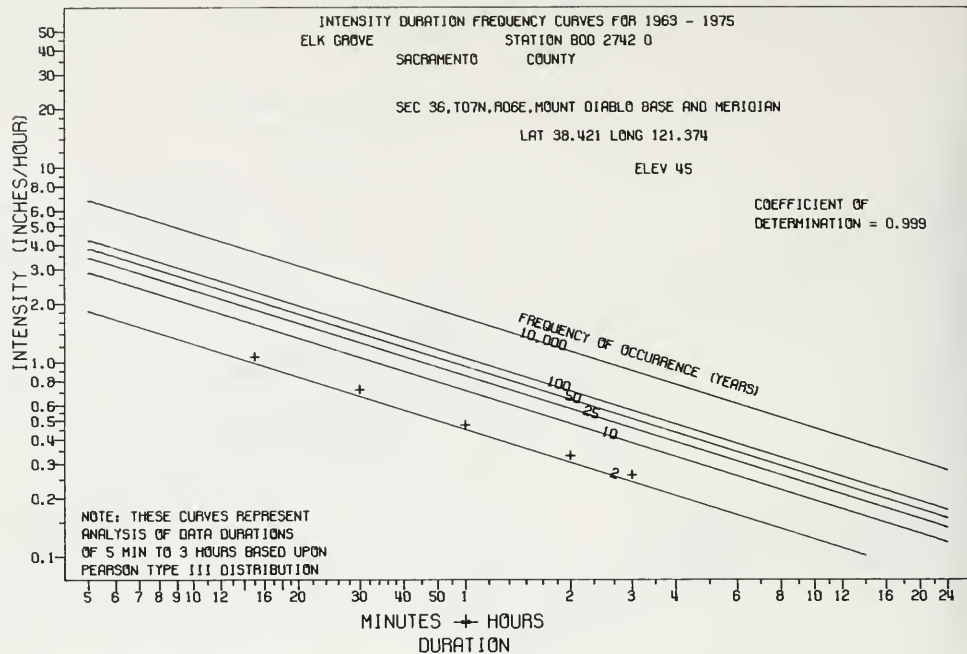


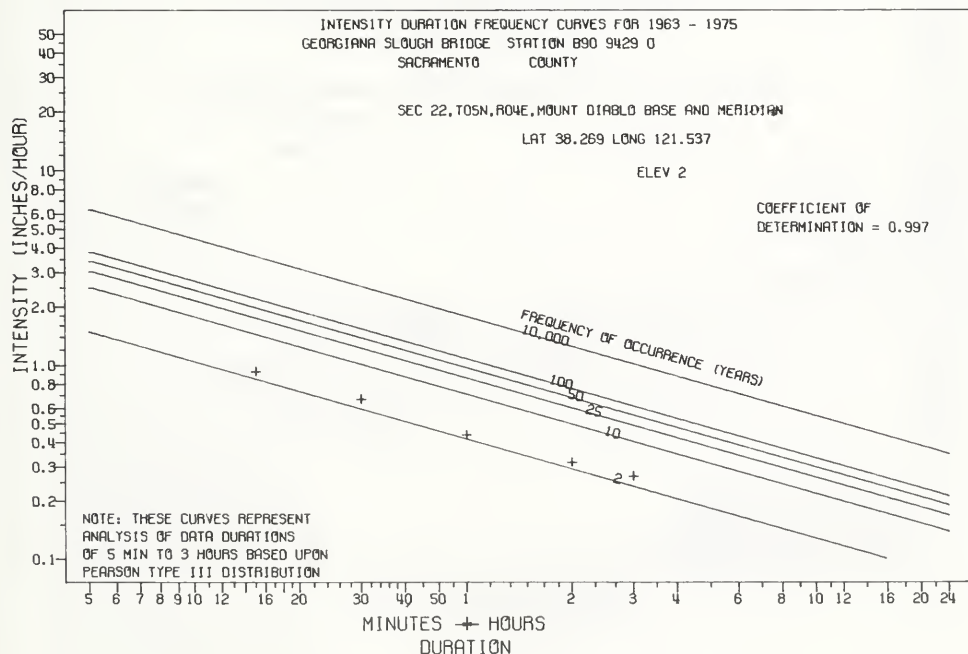
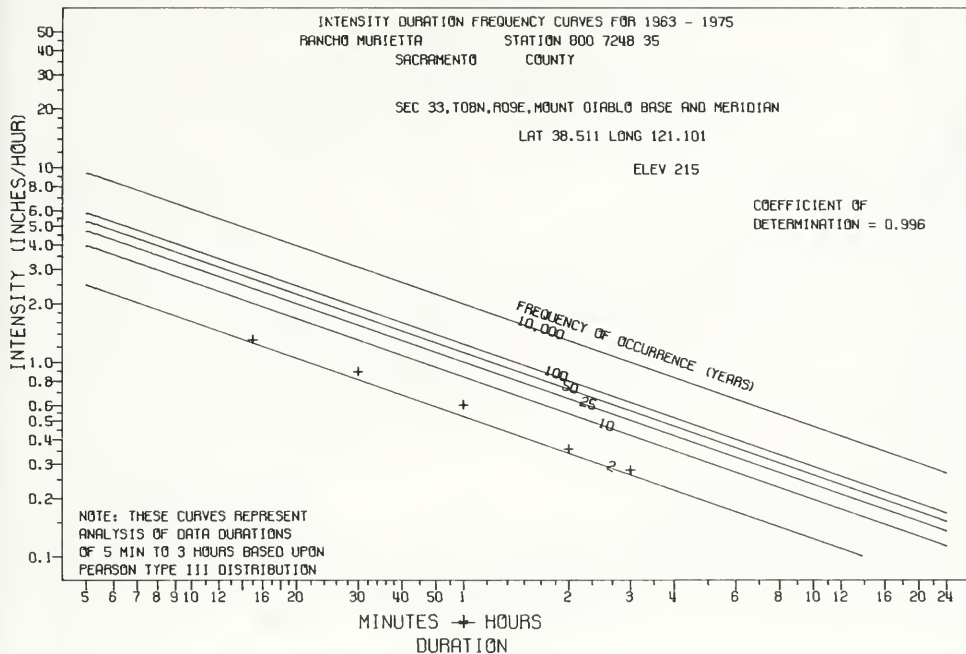
INTENSITY DURATION FREQUENCY CURVES FOR 1903 - 1975  
SACRAMENTO CITY NHS STATION AOD 7633 0  
SACRAMENTO COUNTY

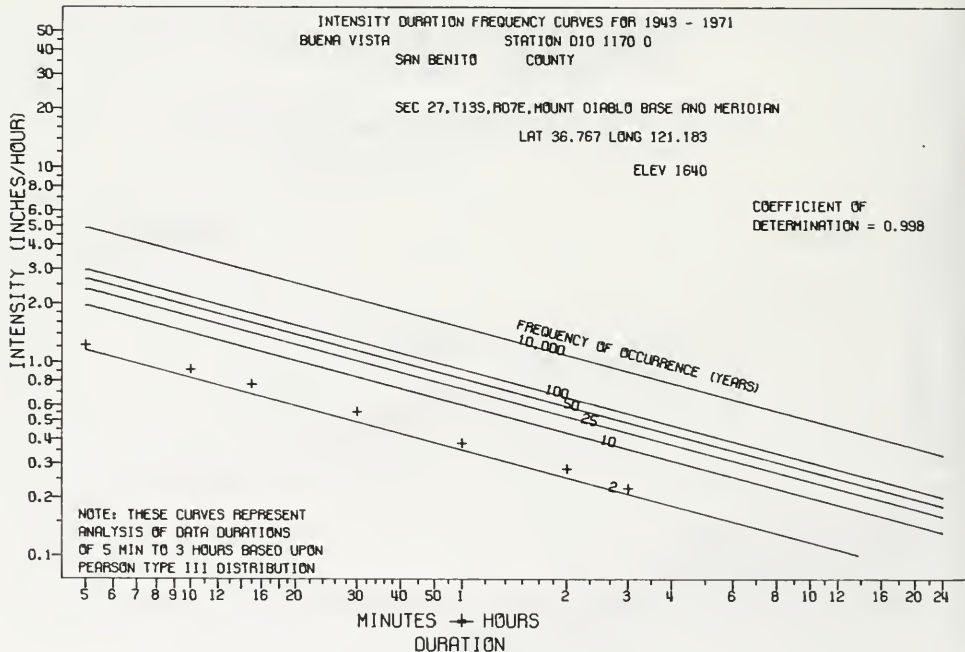
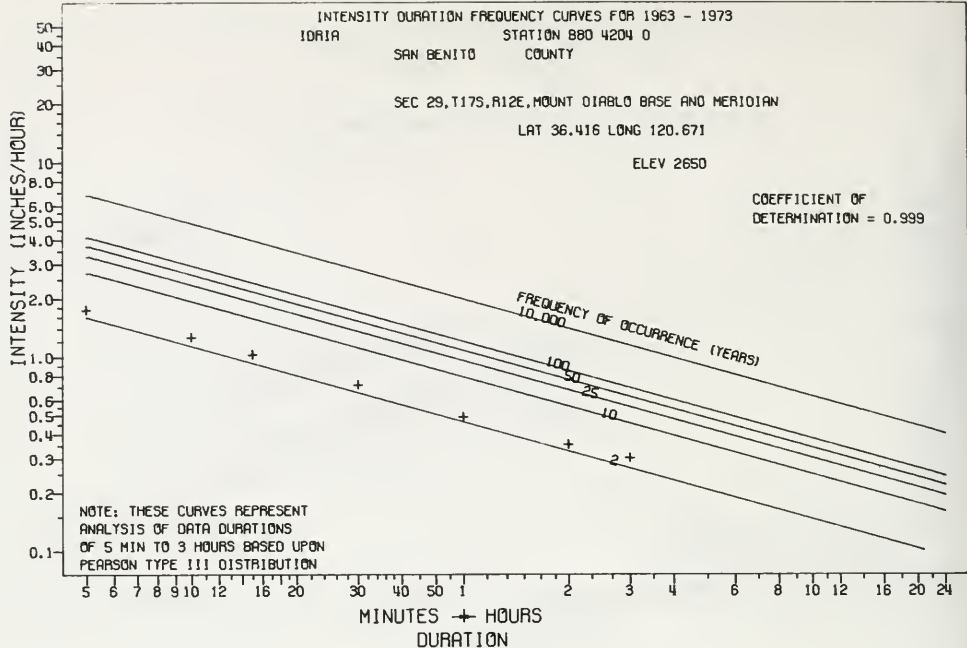
SEC 01, T08N, R04E, MOUNT DIABLO BASE AND MERIDIAN  
LAT 38.417 LONG 121.483  
ELEV 25

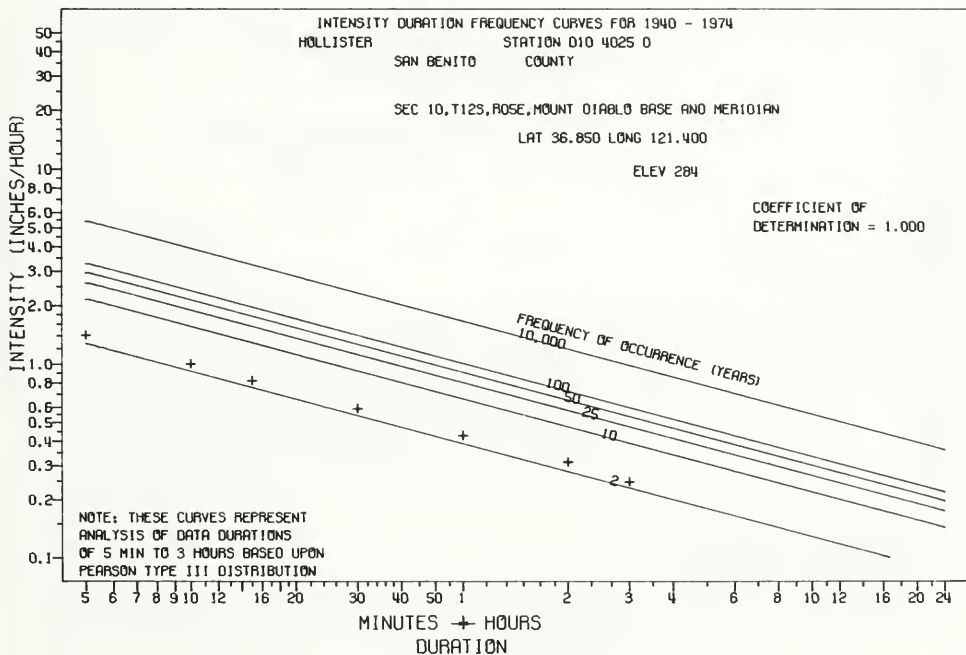
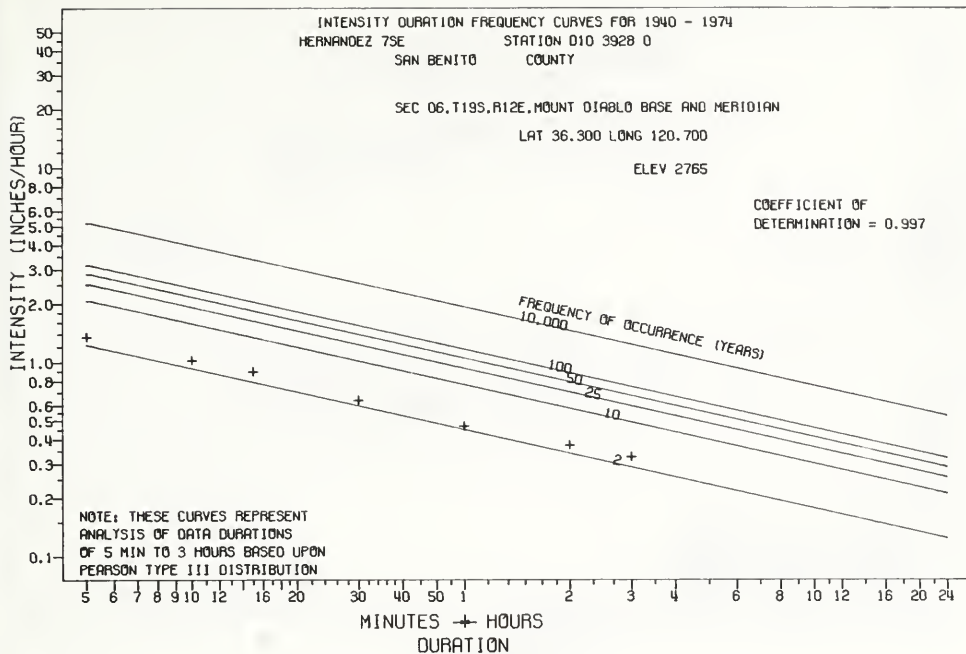
COEFFICIENT OF  
DETERMINATION = 0.998

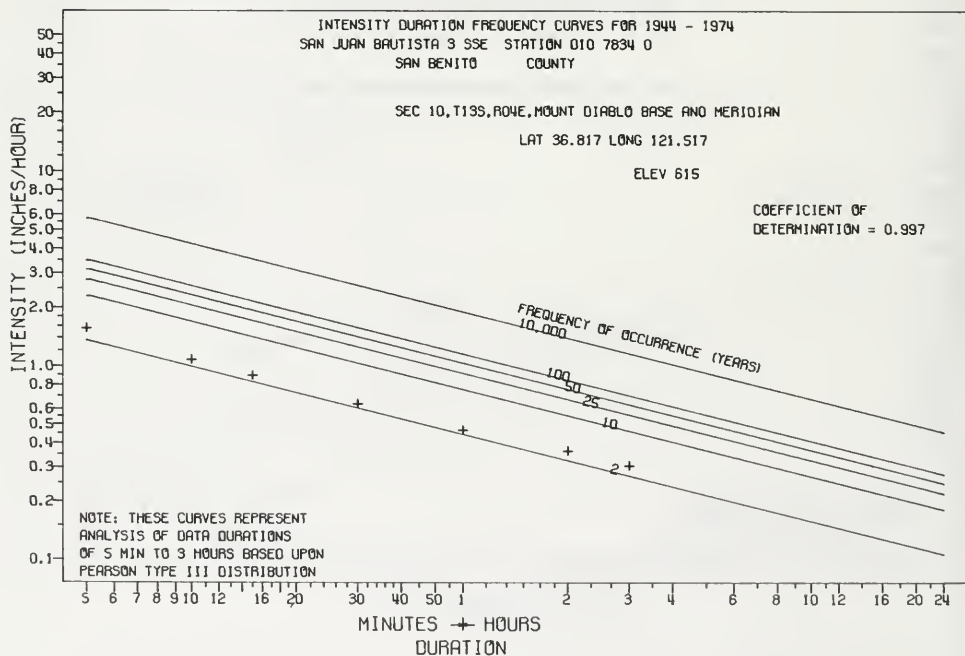
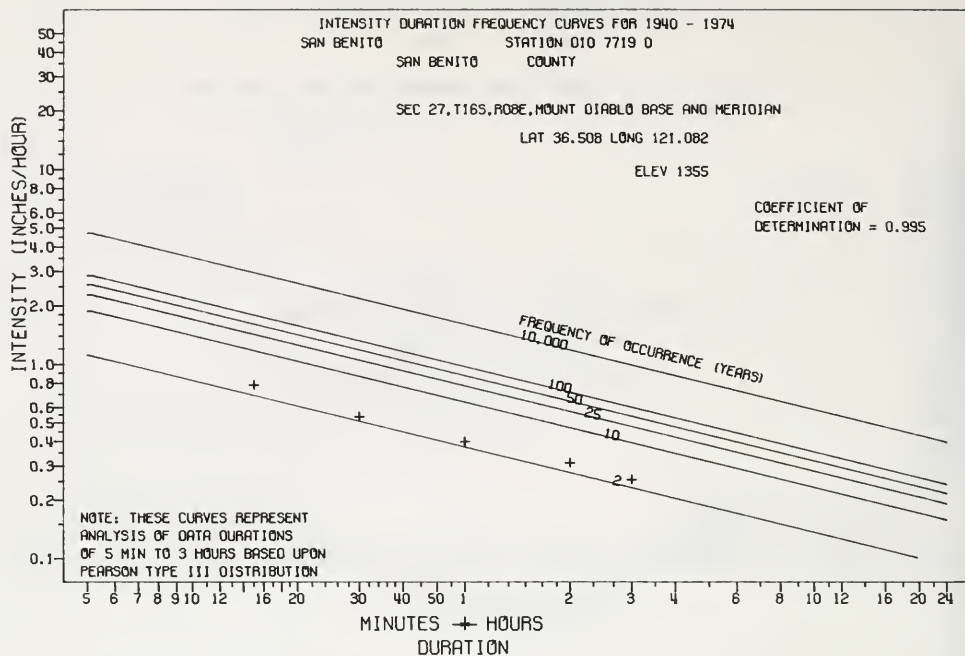


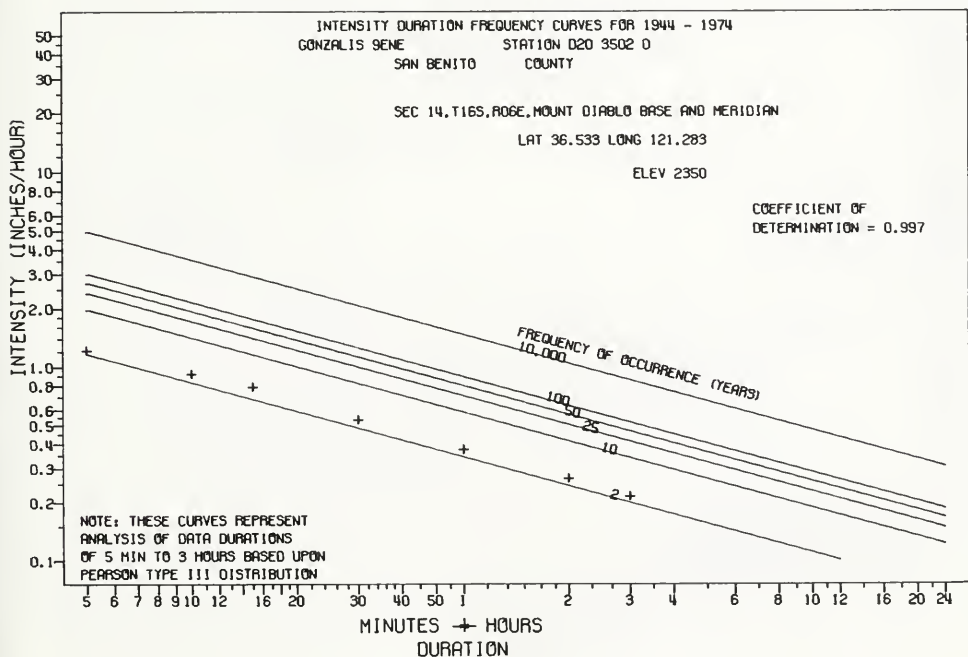
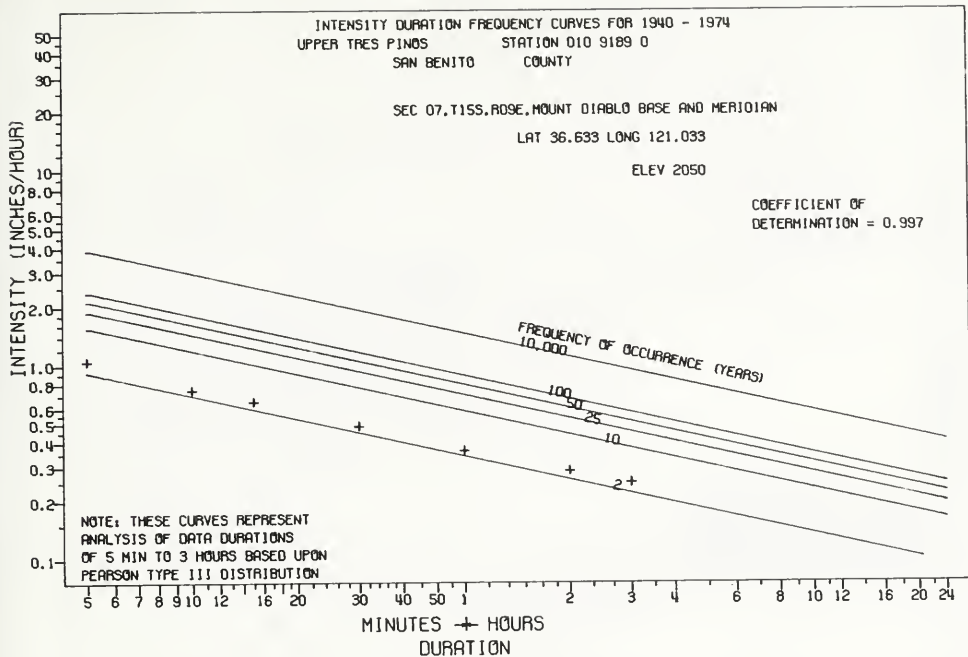




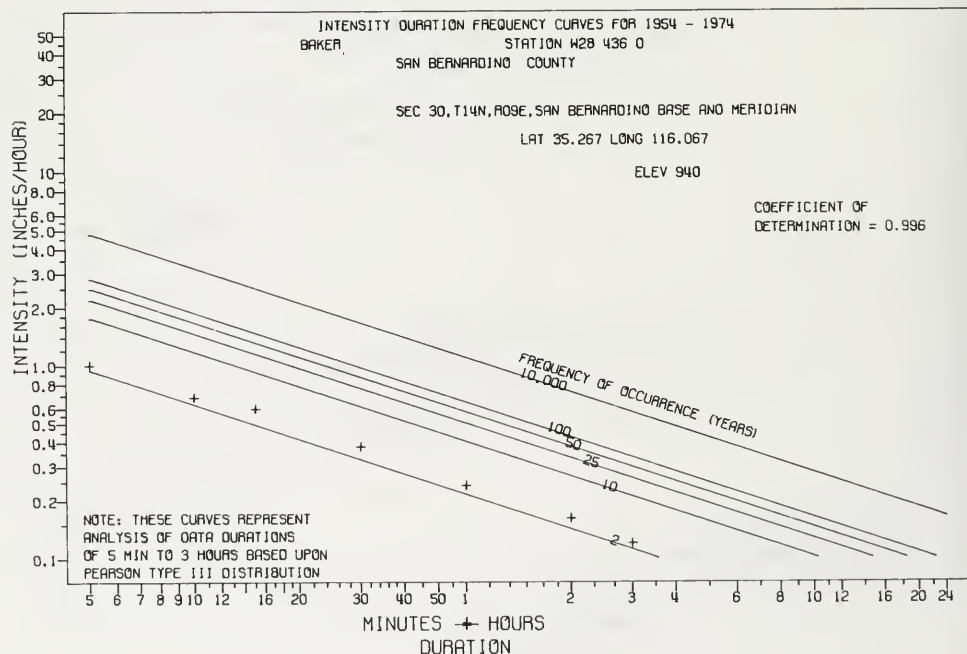
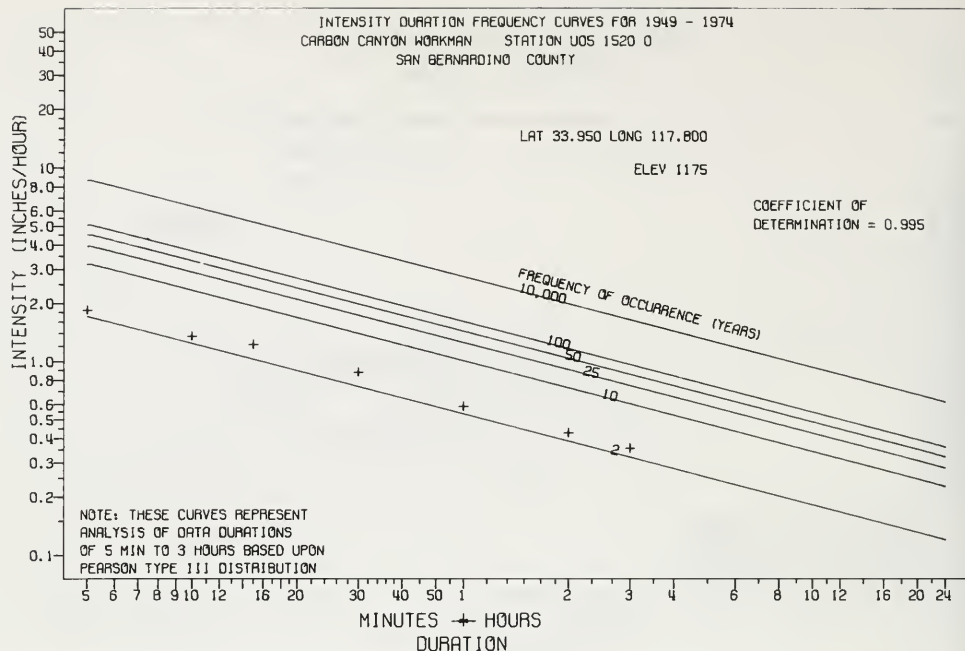




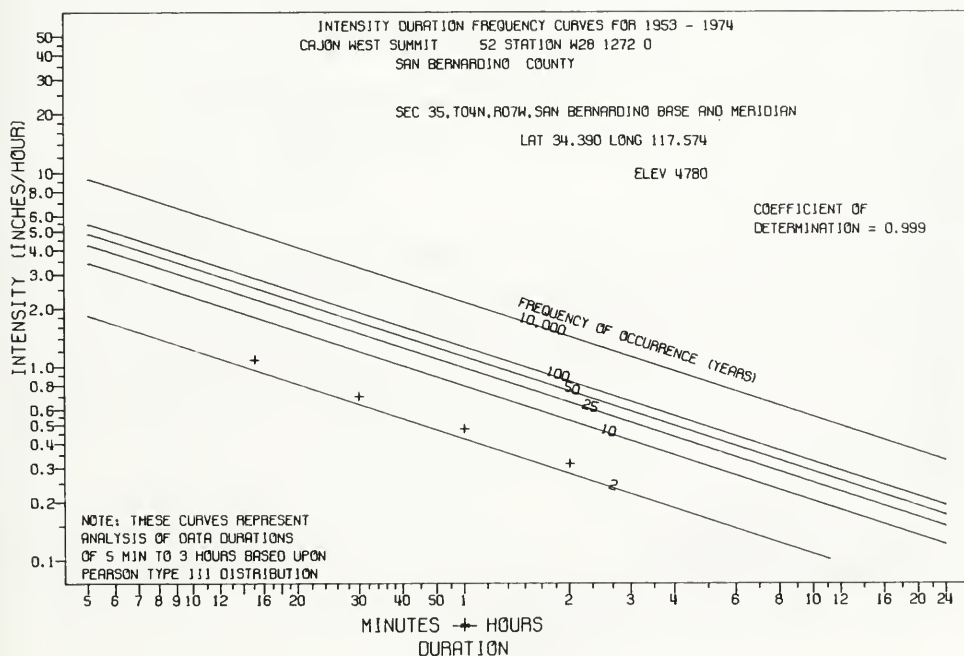
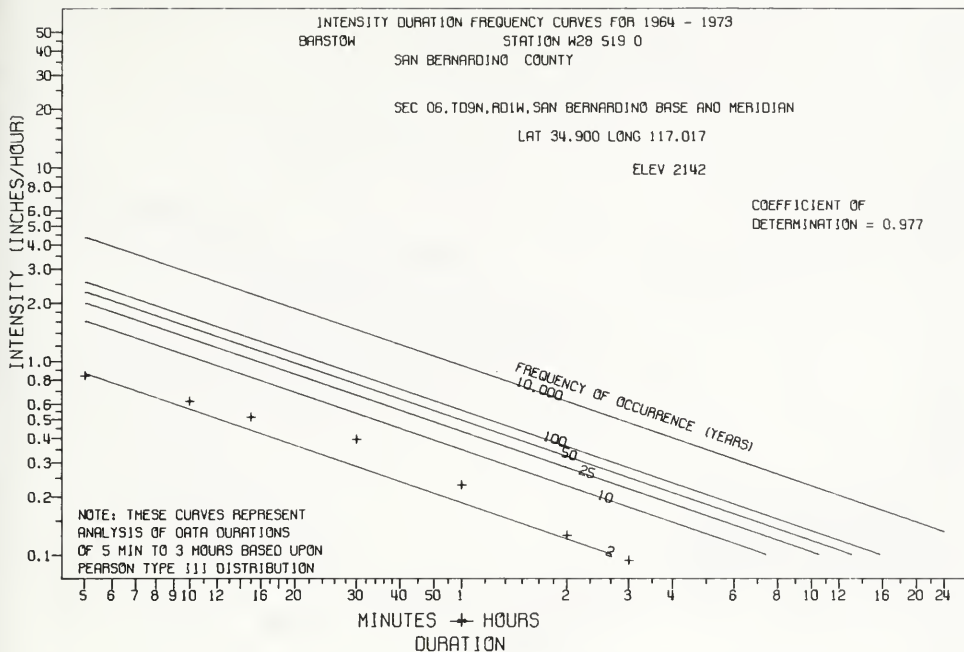


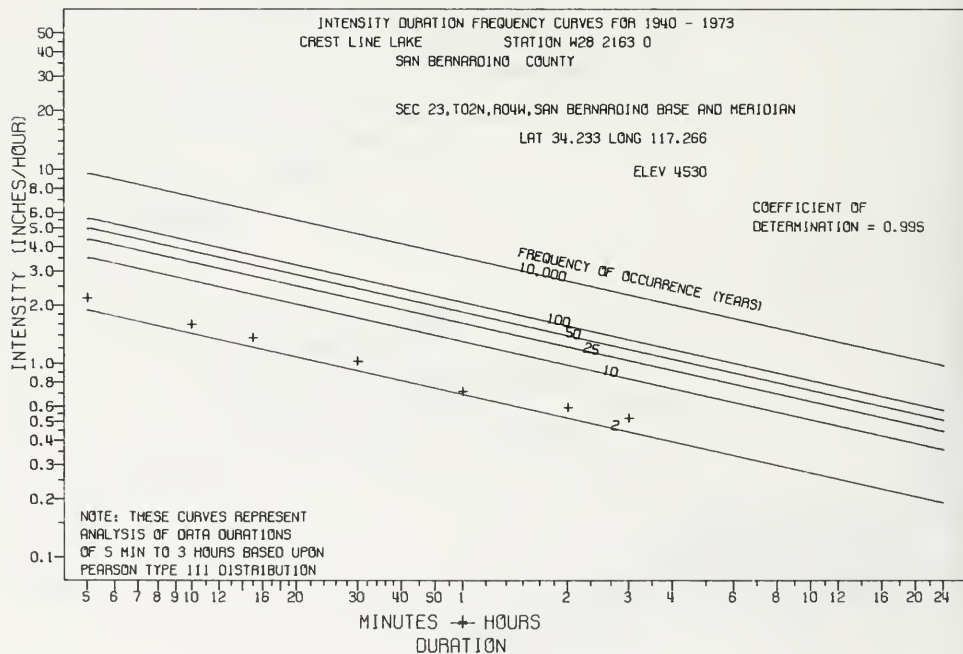
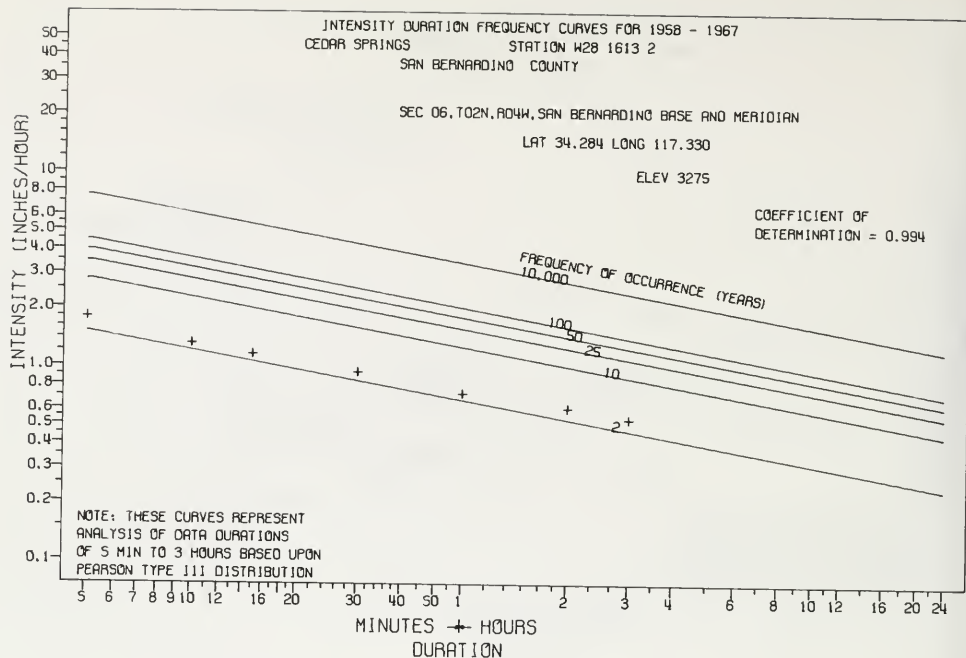


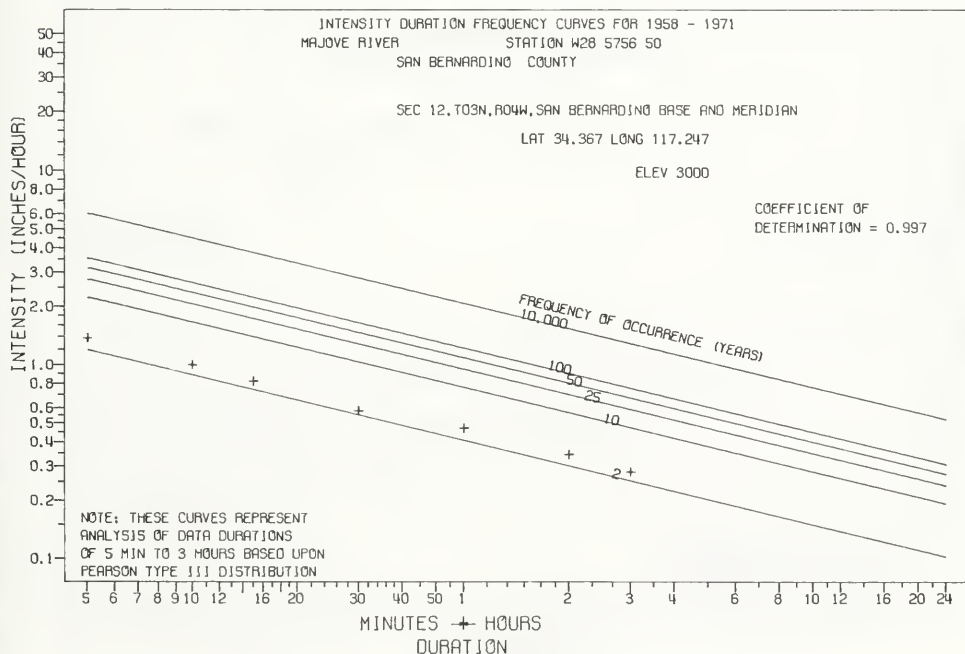
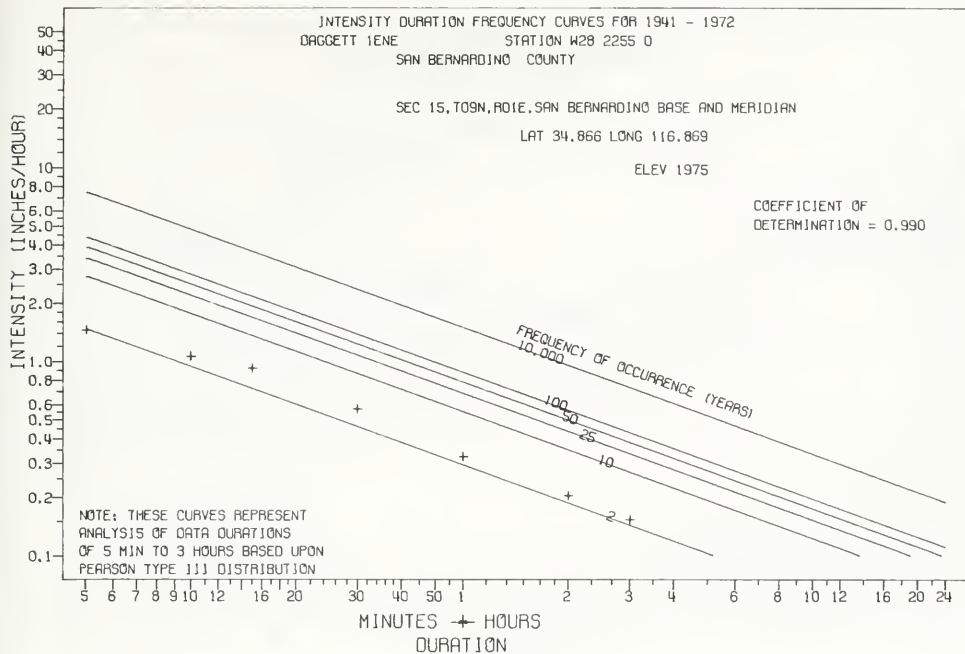


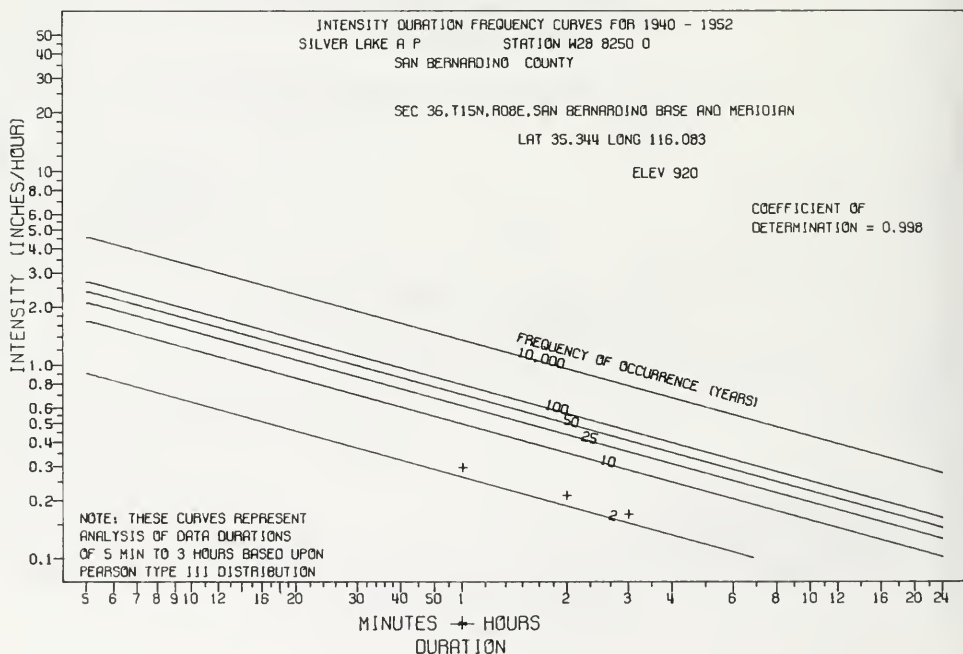
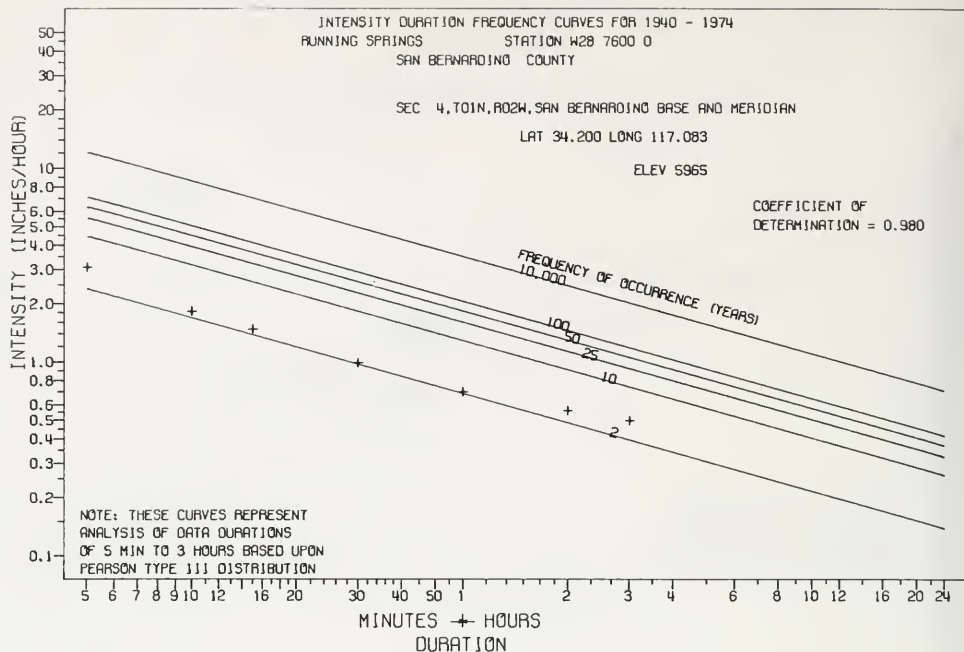


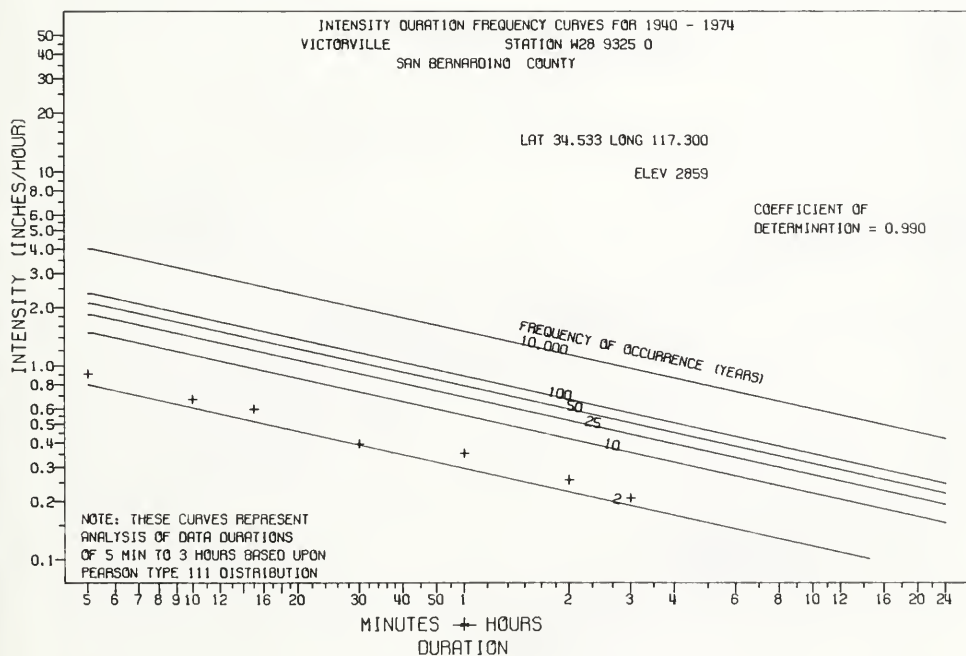
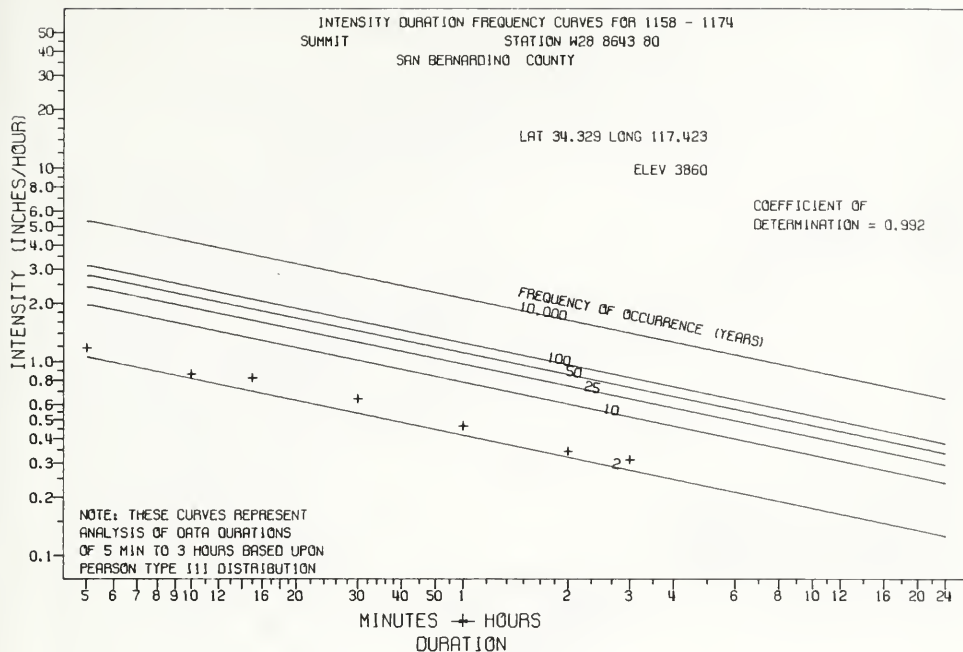


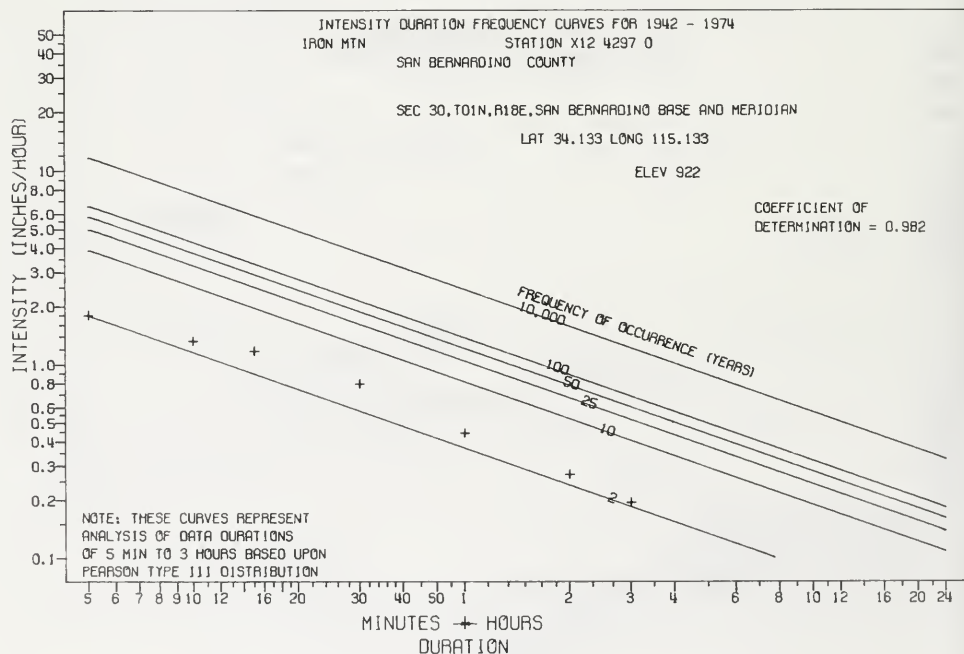
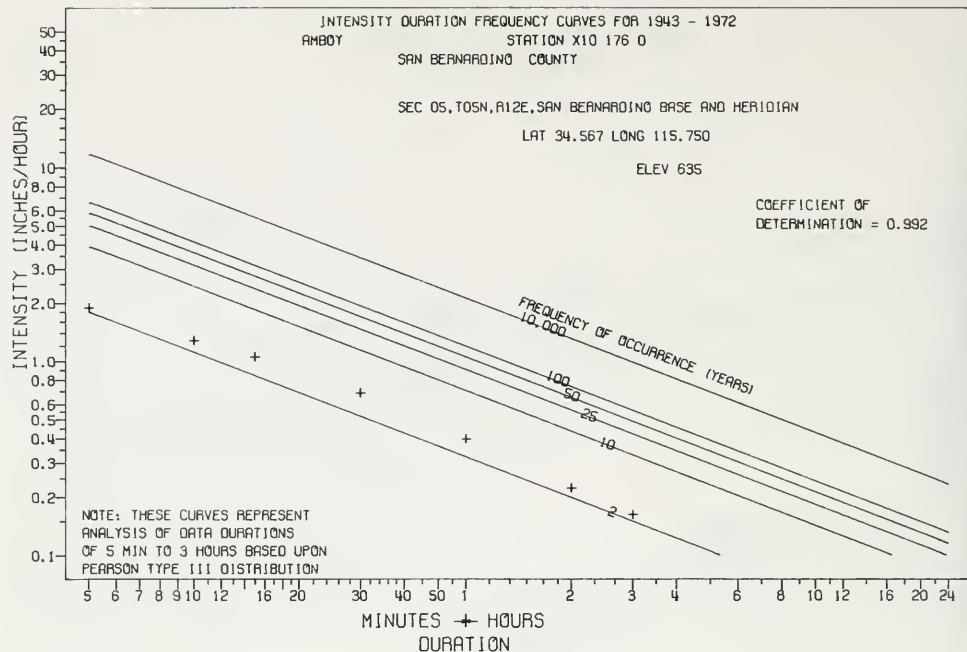


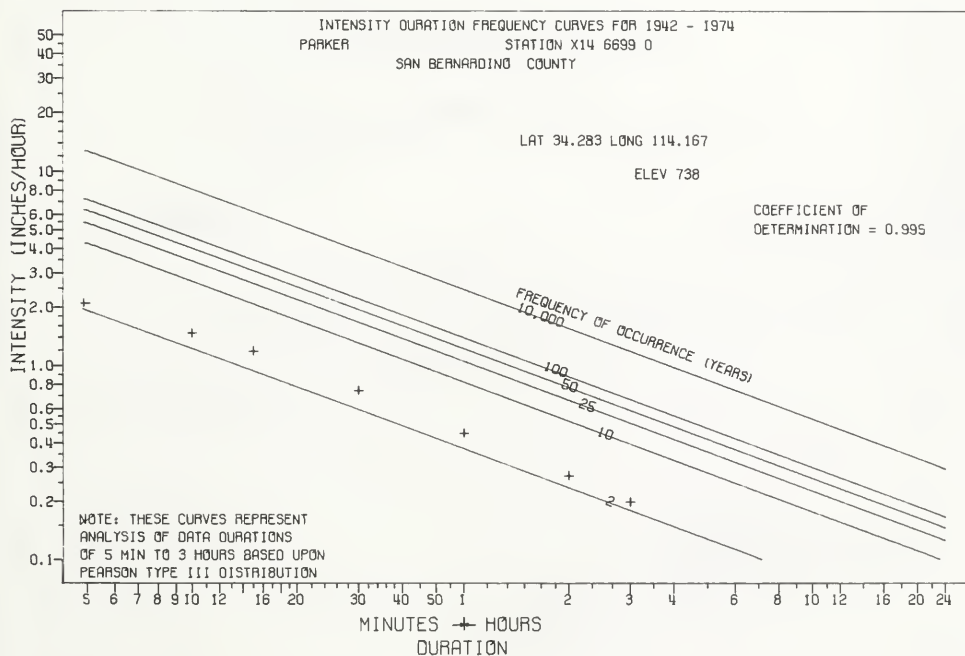
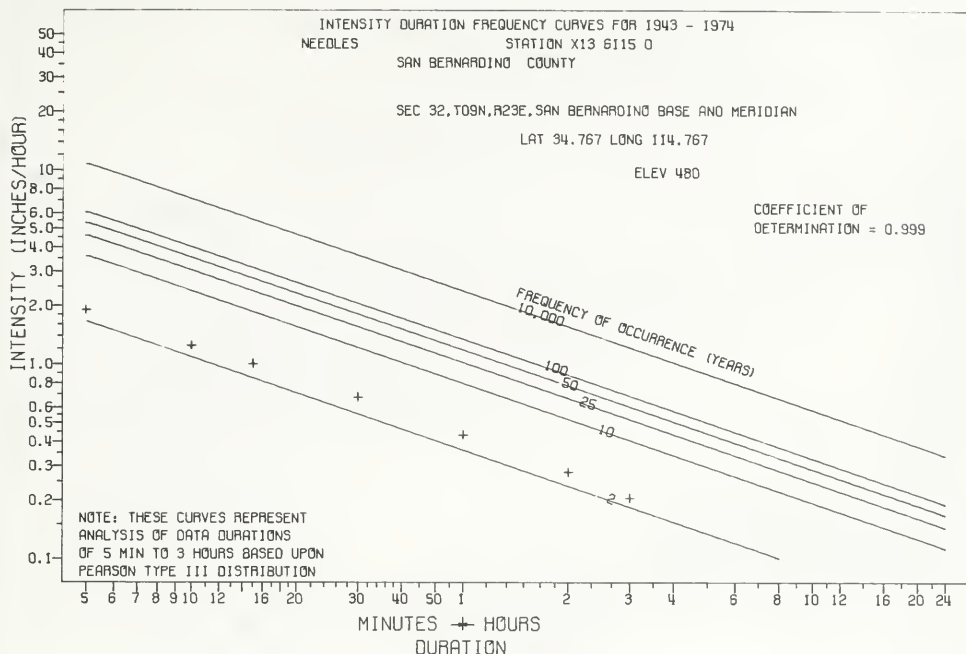


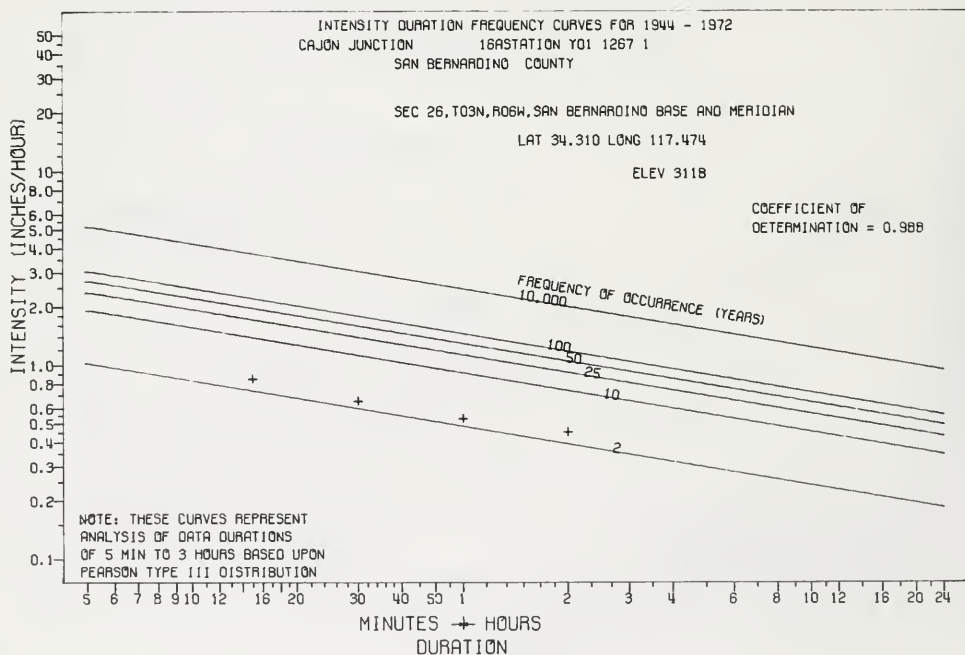
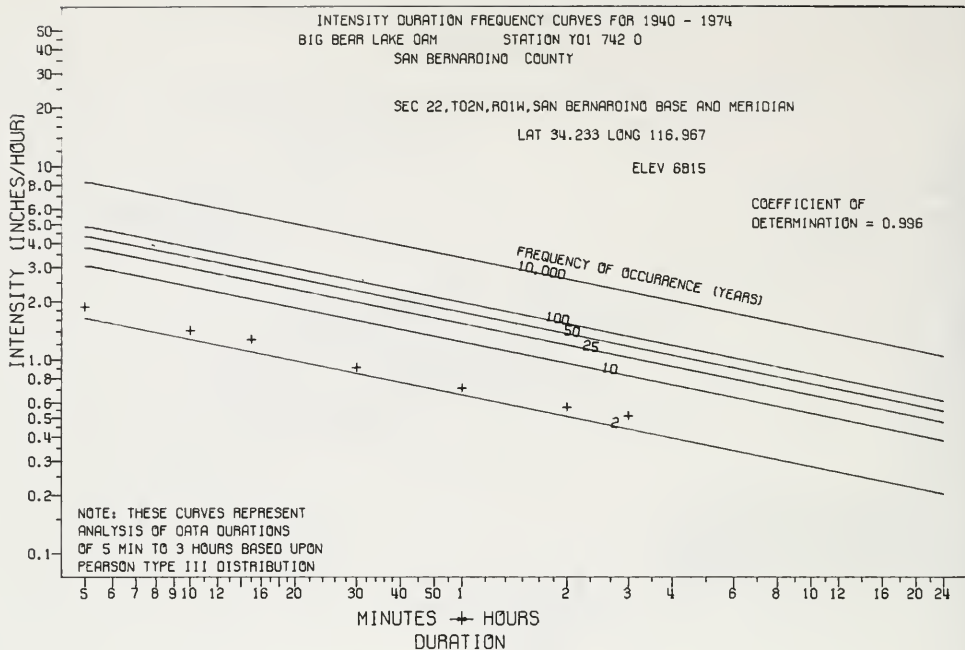














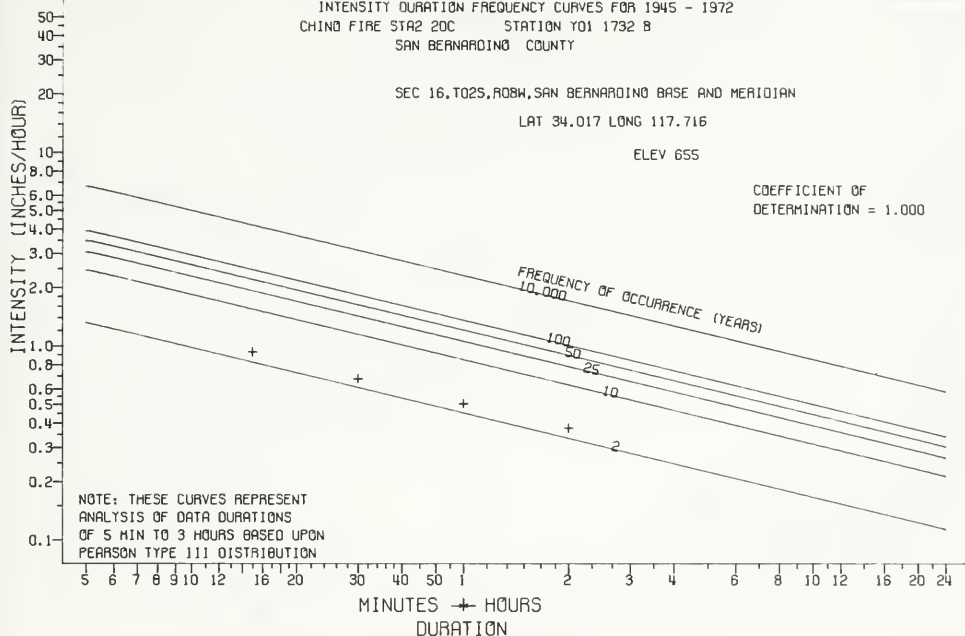
INTENSITY DURATION FREQUENCY CURVES FOR 1945 - 1972  
CHINO FIRE STA2 20C STATION Y01 1732 B  
SAN BERNARDINO COUNTY

SEC 16, T02S, R08W, SAN BERNARDINO BASE AND MERIDIAN

LAT 34.017 LONG 117.716

ELEV 655

COEFFICIENT OF  
DETERMINATION = 1.000



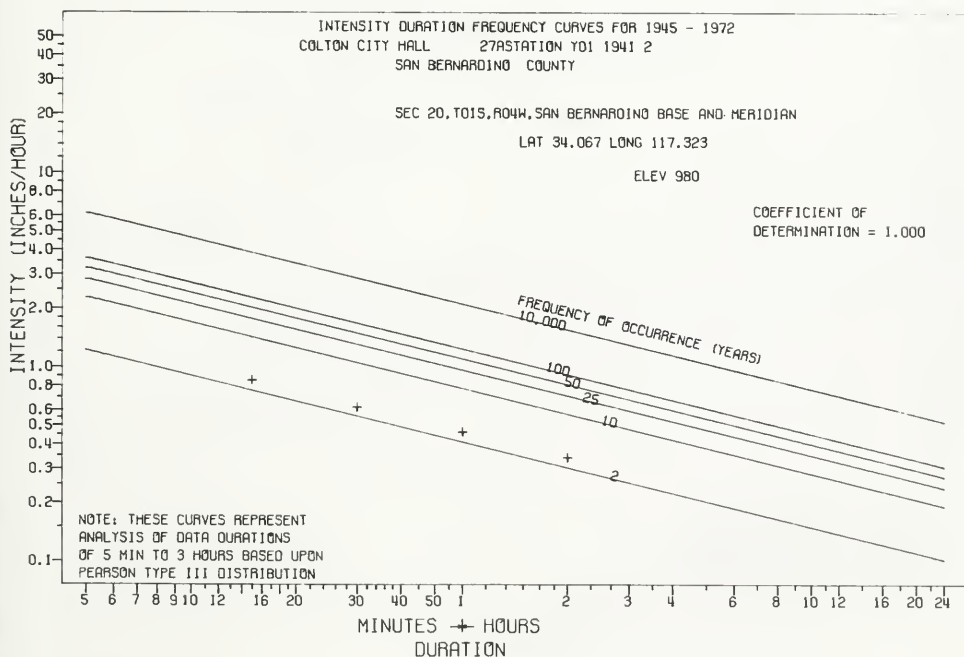
INTENSITY DURATION FREQUENCY CURVES FOR 1945 - 1972  
COLTON CITY HALL STATION Y01 1941 2  
SAN BERNARDINO COUNTY

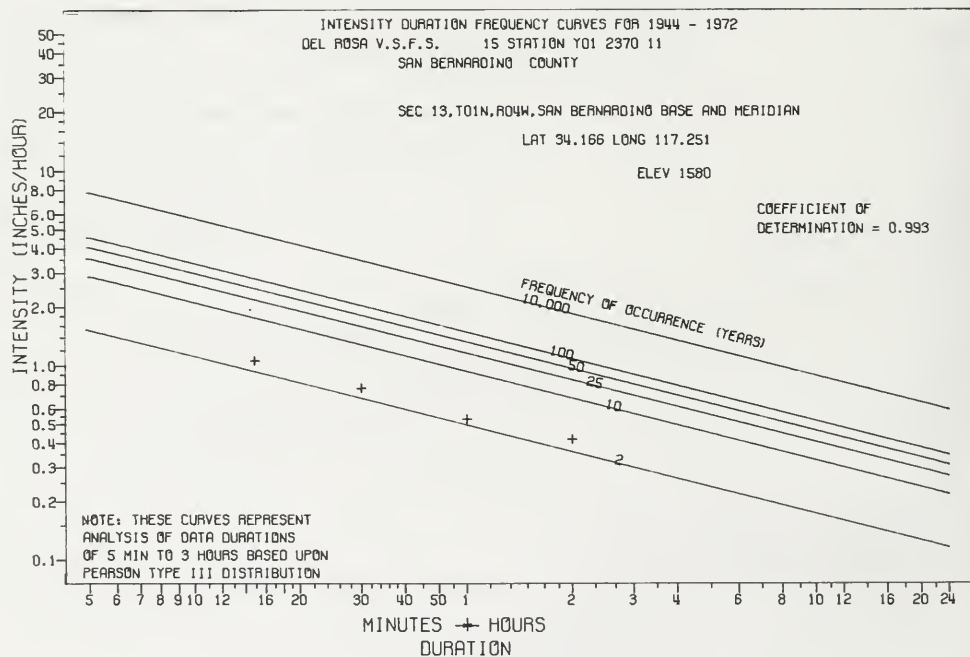
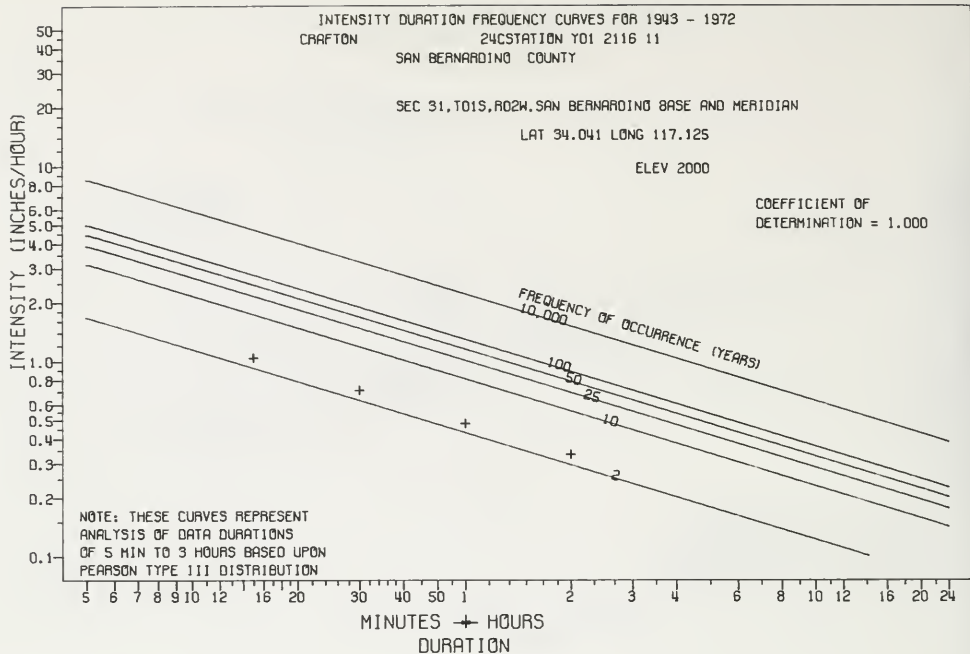
SEC 20, T01S, R04W, SAN BERNARDINO BASE AND MERIDIAN

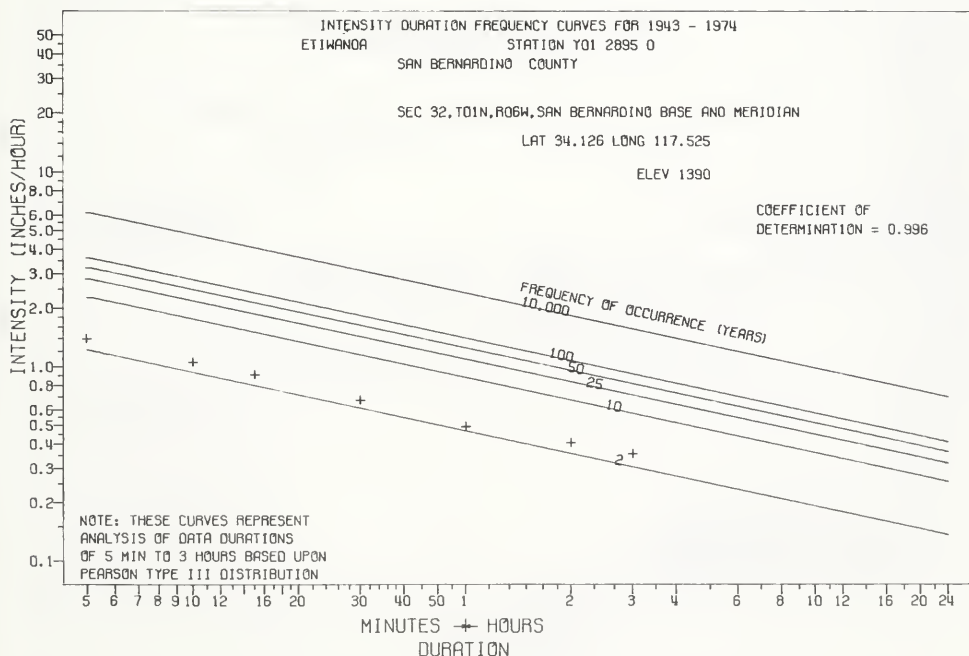
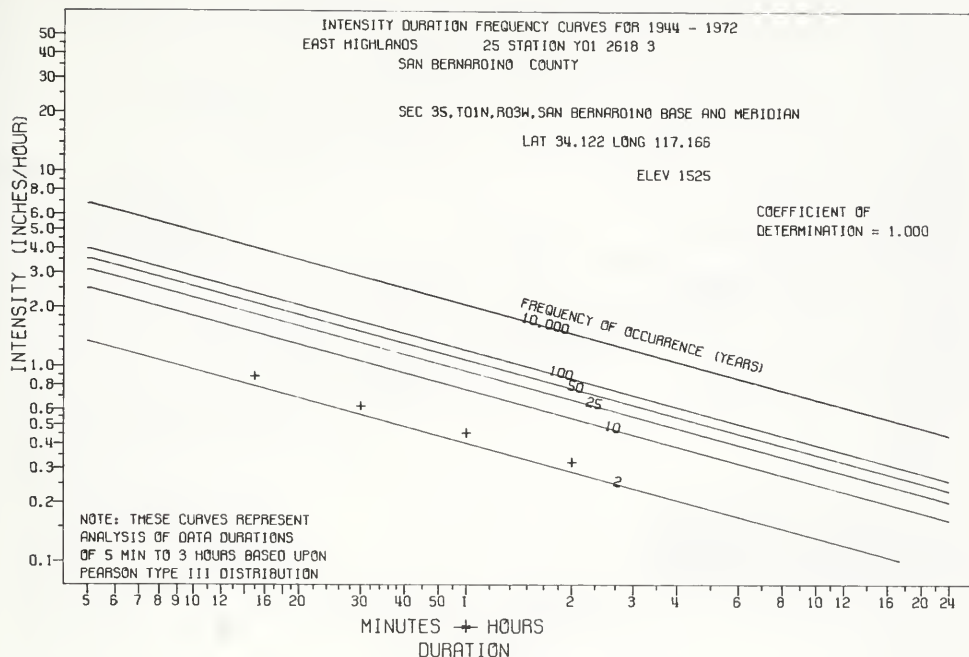
LAT 34.067 LONG 117.323

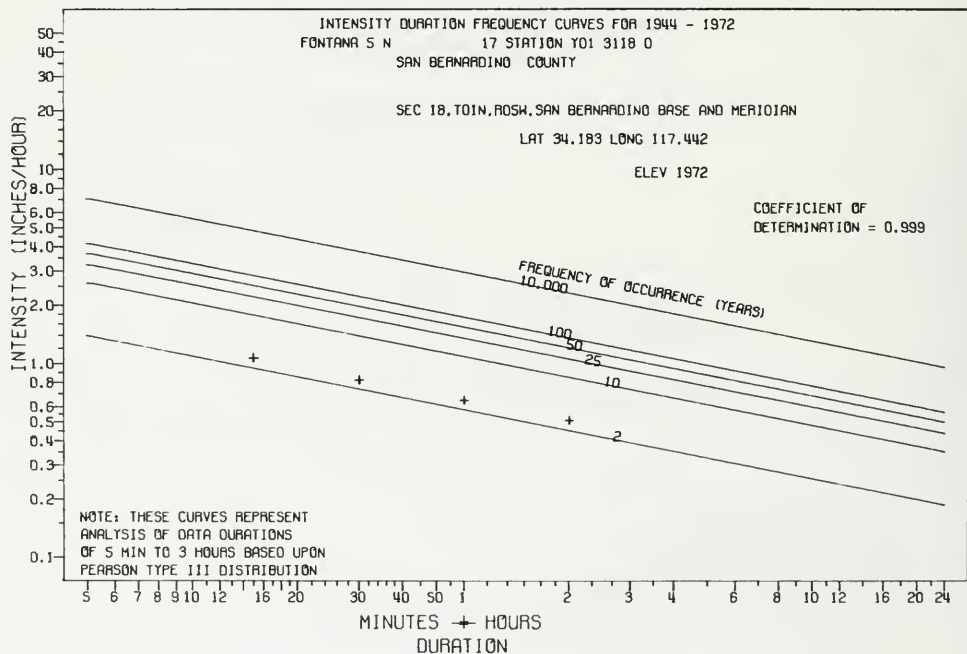
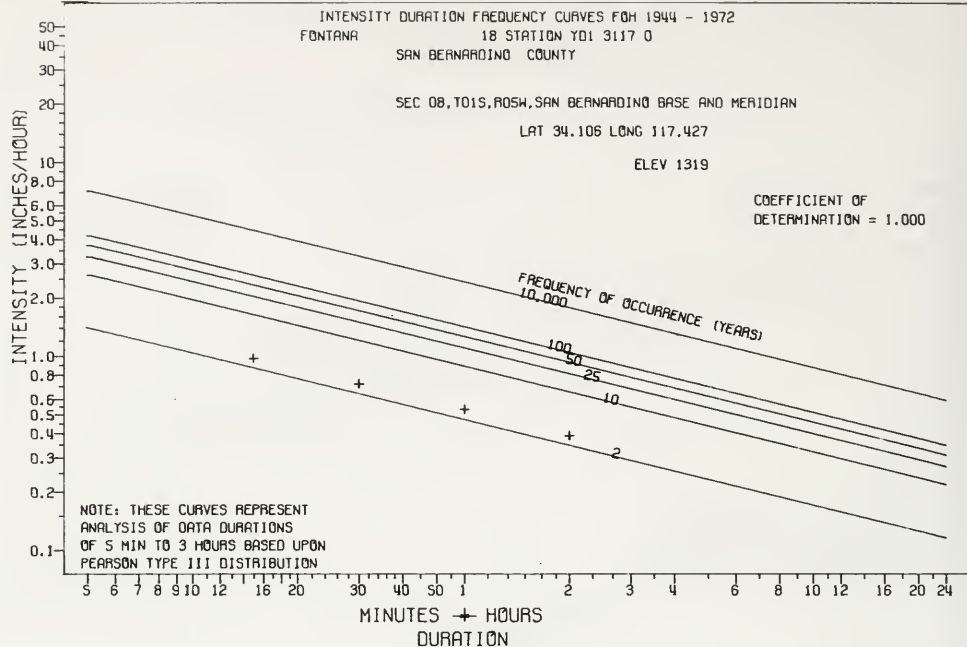
ELEV 980

COEFFICIENT OF  
DETERMINATION = 1.000









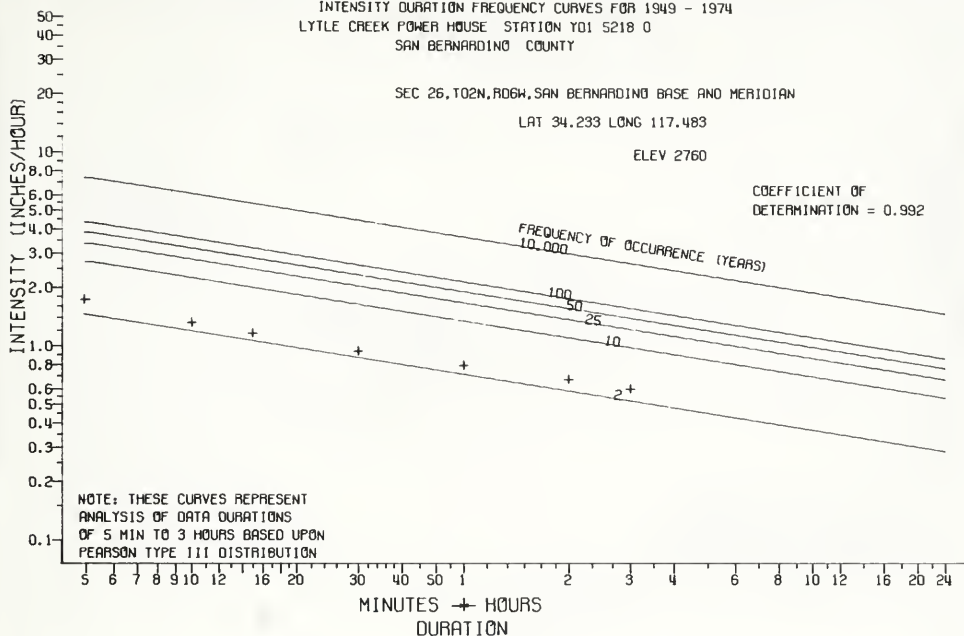
INTENSITY DURATION FREQUENCY CURVES FOR 1949 - 1974  
LYTLE CREEK POWER HOUSE STATION Y01 5218 0  
SAN BERNARDINO COUNTY

SEC 26, T02N, R06W, SAN BERNARDINO BASE AND MERIDIAN

LAT 34.233 LONG 117.483

ELEV 2760

COEFFICIENT OF  
DETERMINATION = 0.992



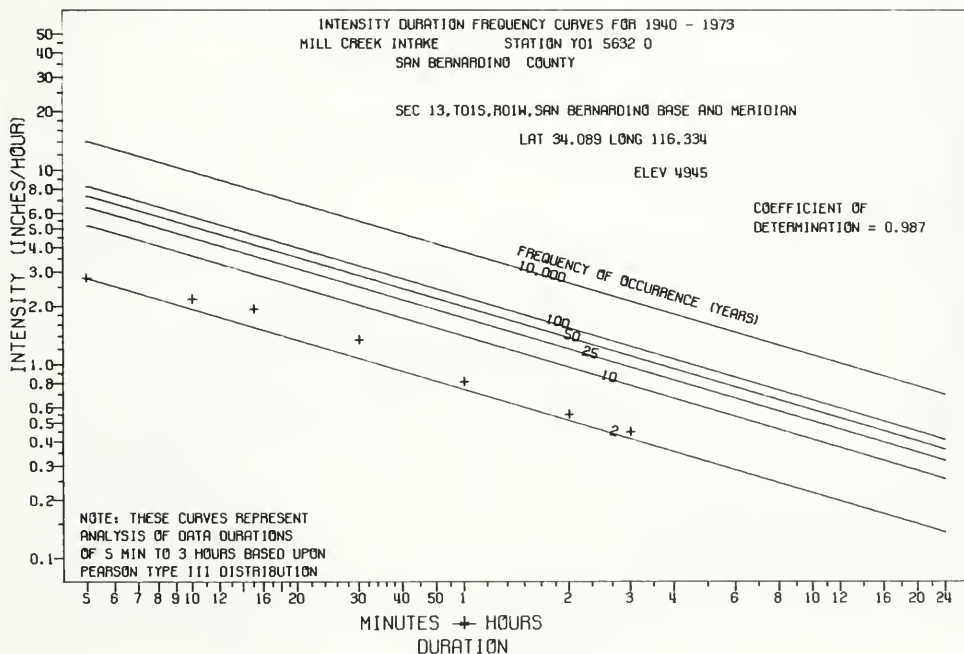
INTENSITY DURATION FREQUENCY CURVES FOR 1940 - 1973  
MILL CREEK INTAKE STATION Y01 5632 0  
SAN BERNARDINO COUNTY

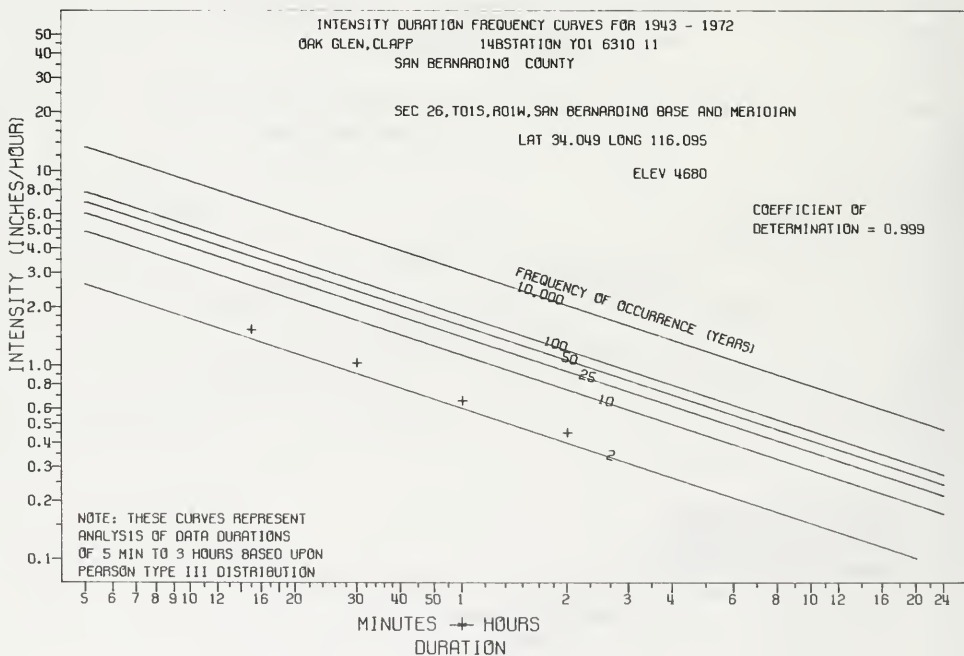
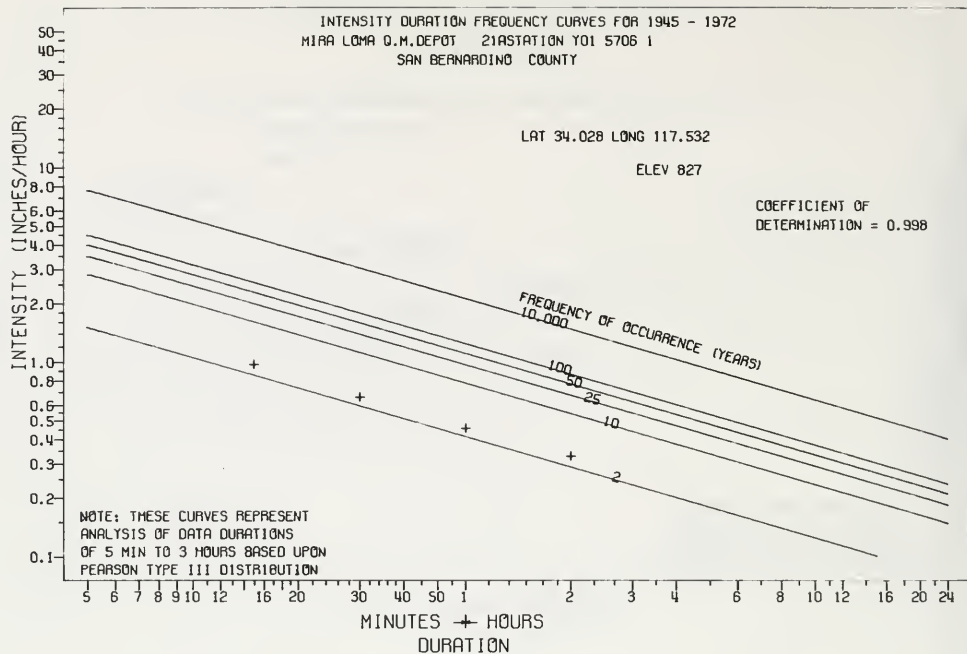
SEC 13, T01S, R01W, SAN BERNARDINO BASE AND MERIDIAN

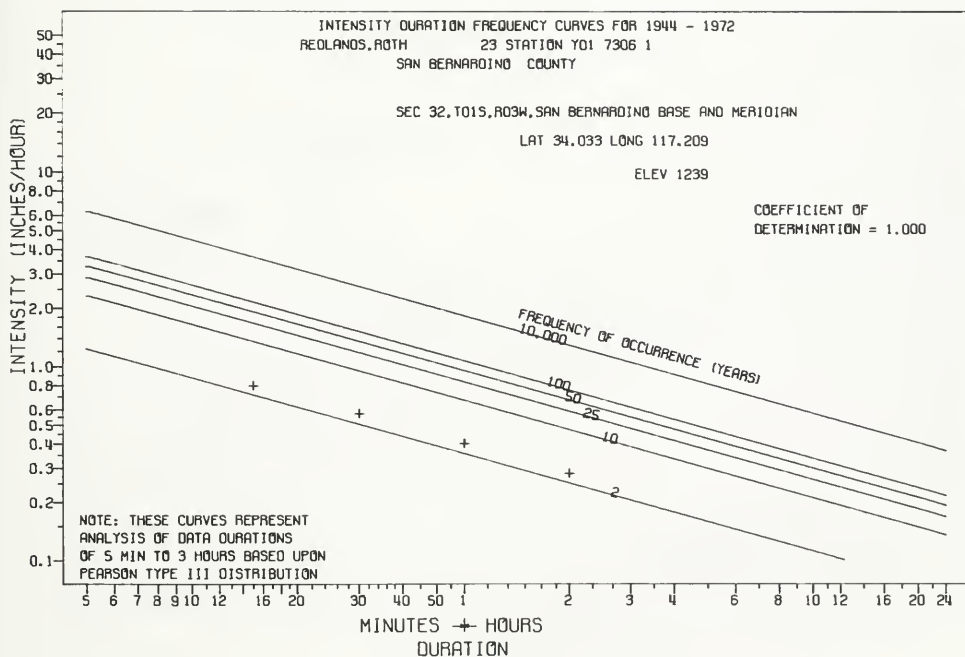
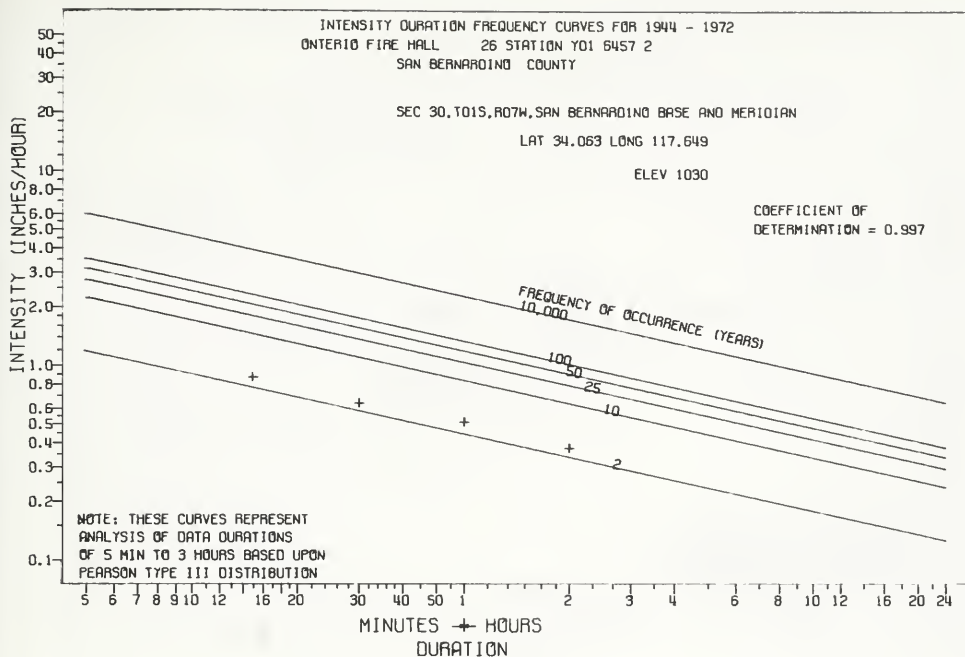
LAT 34.089 LONG 116.334

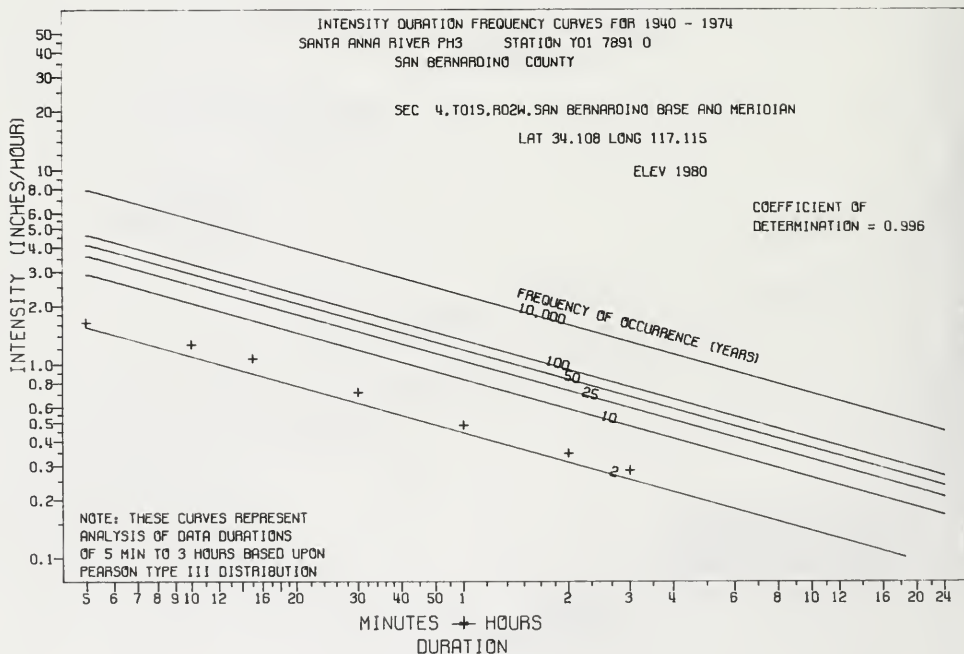
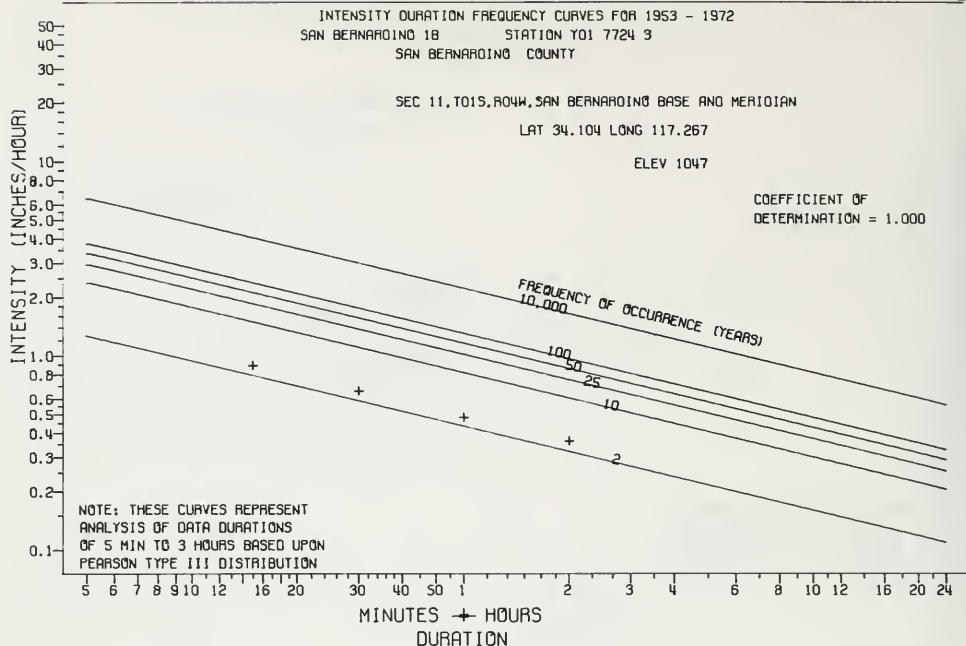
ELEV 4945

COEFFICIENT OF  
DETERMINATION = 0.987

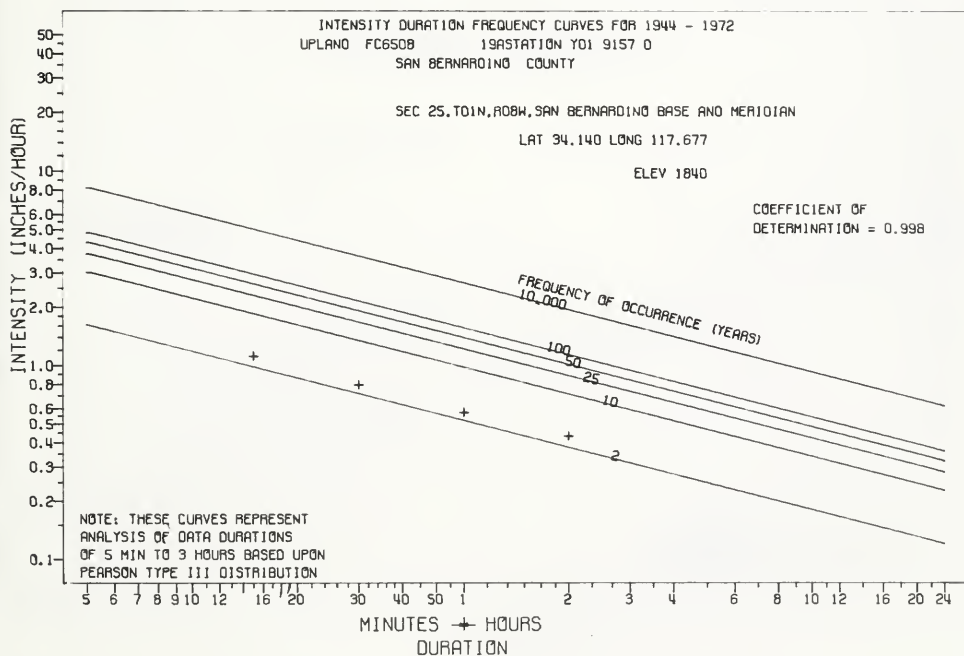
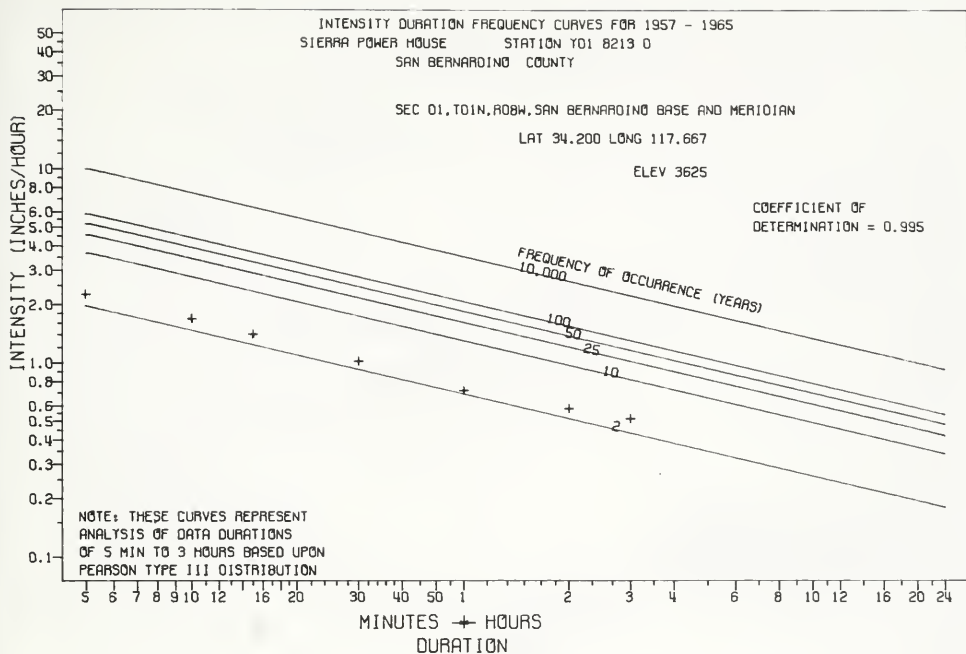


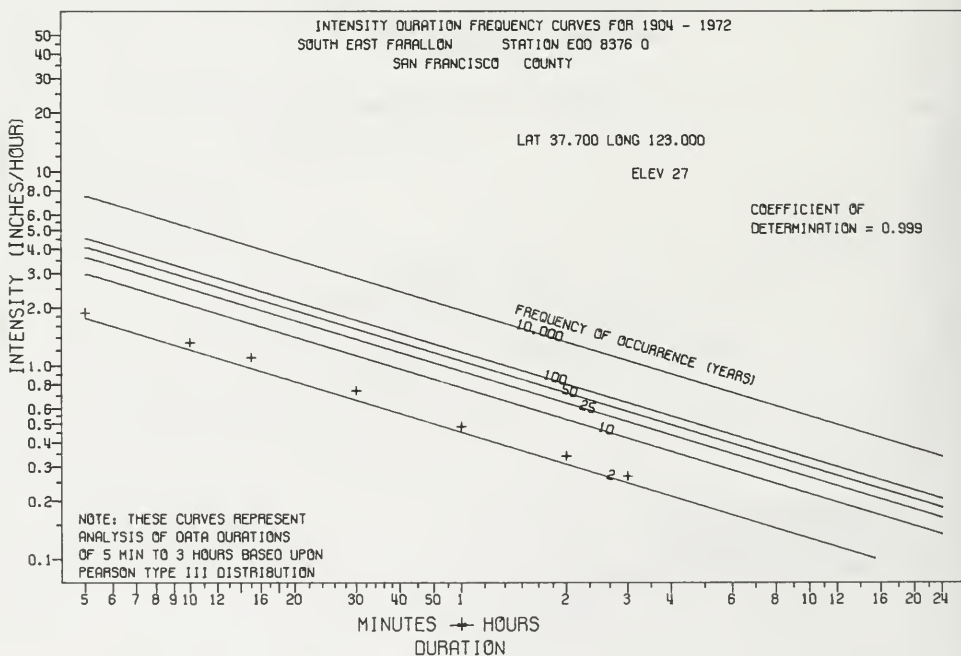
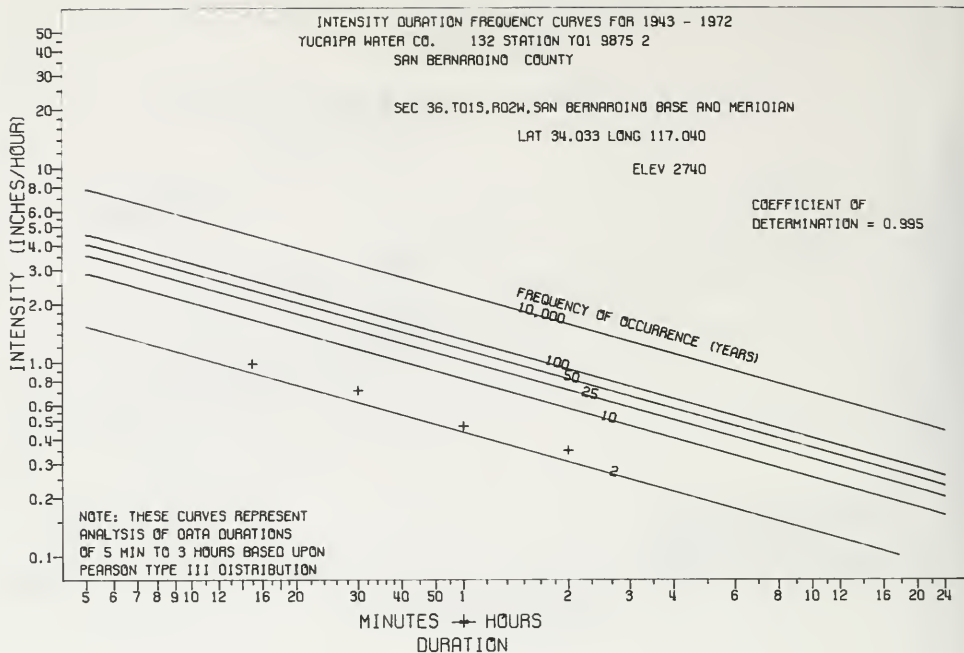


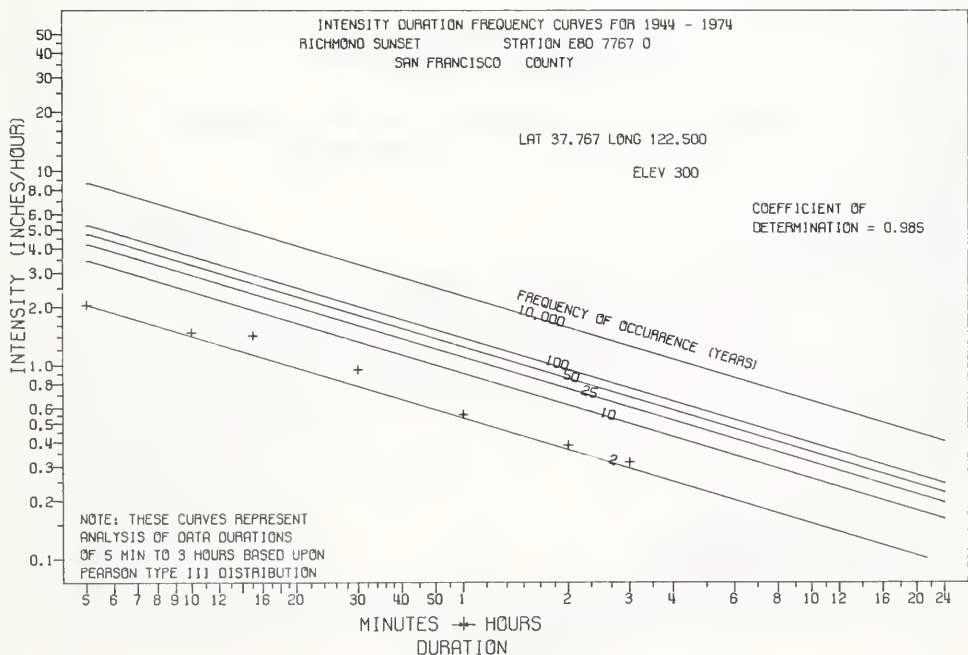
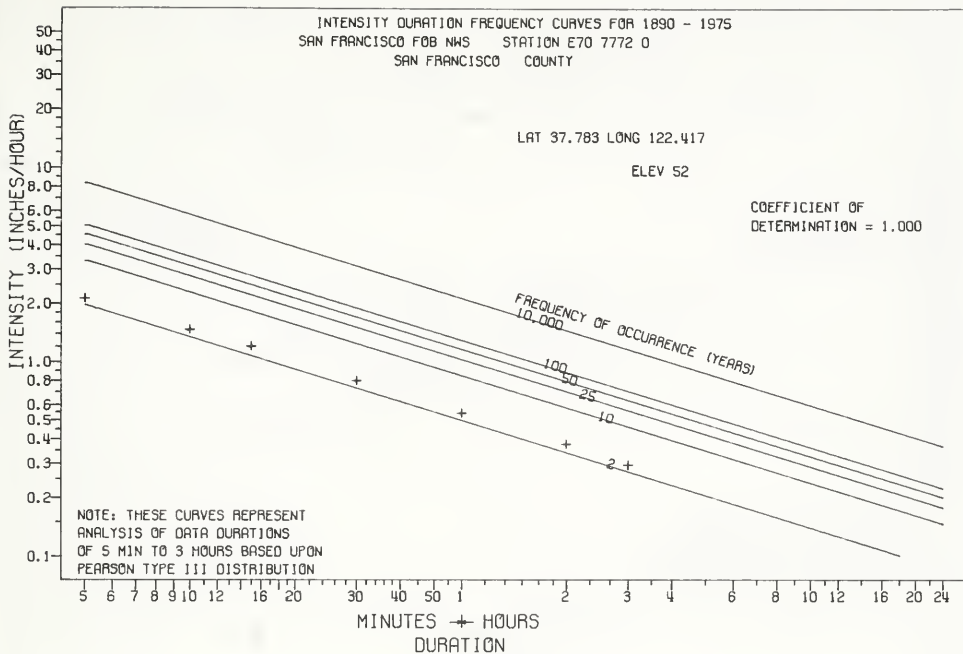


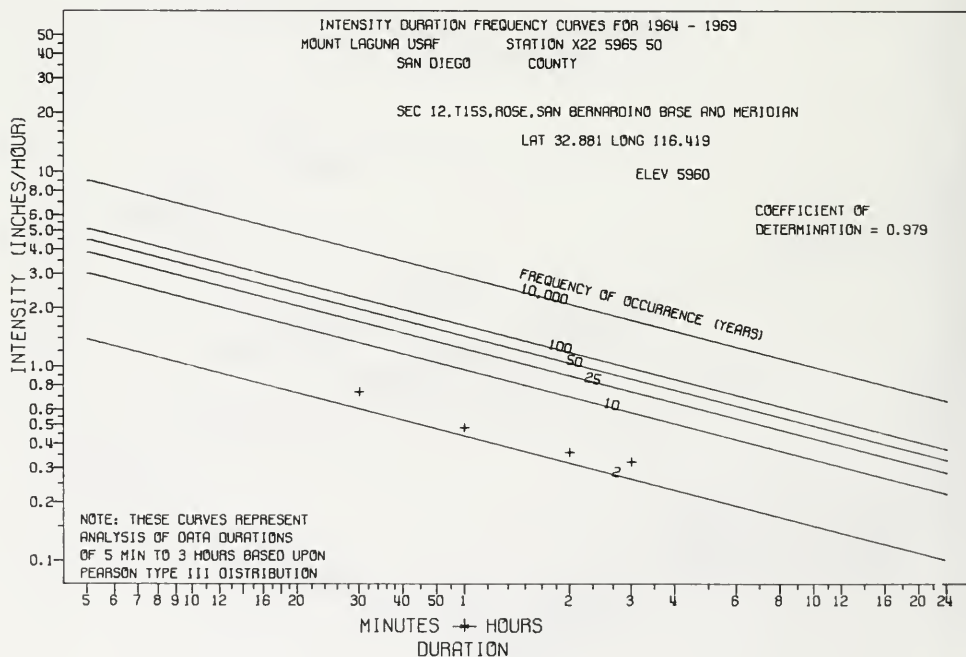
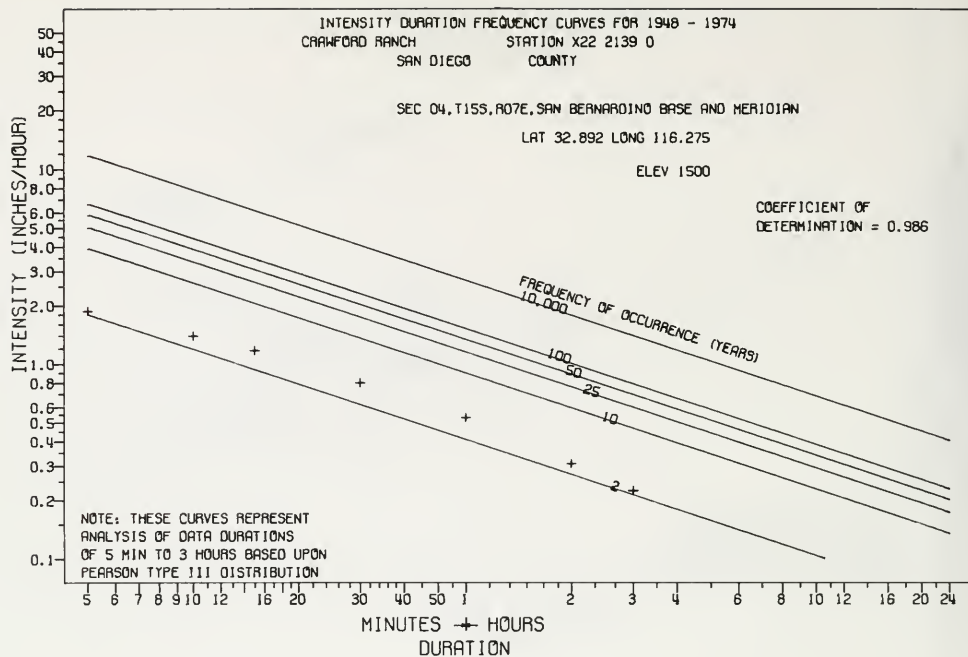


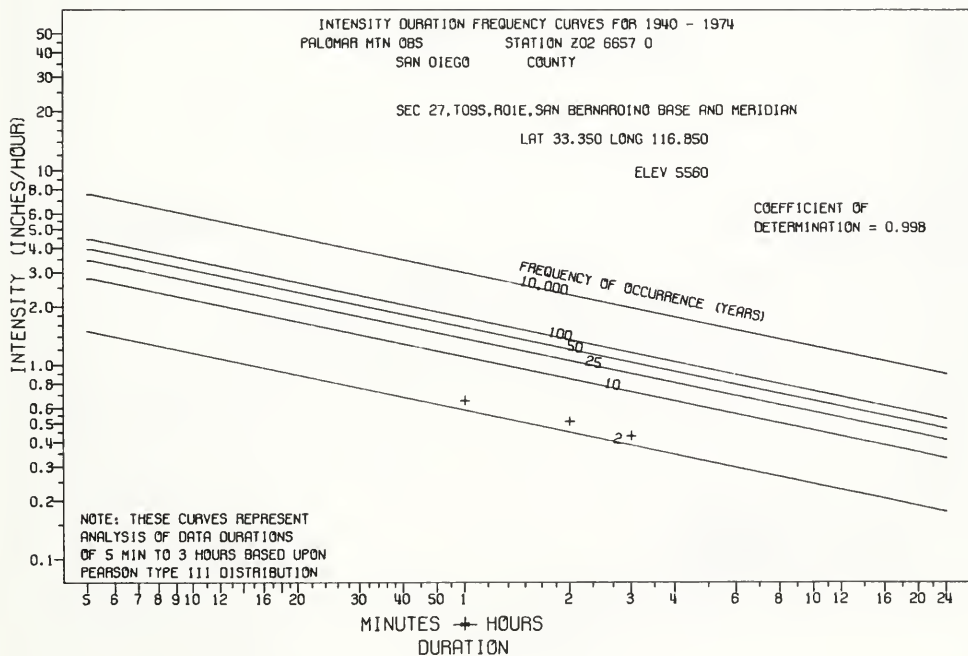
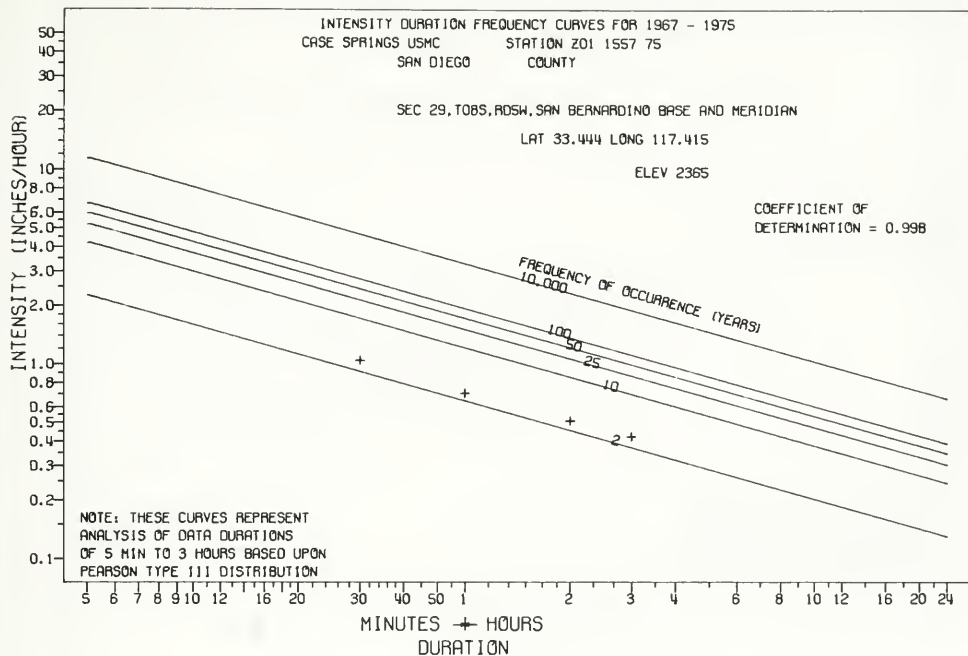


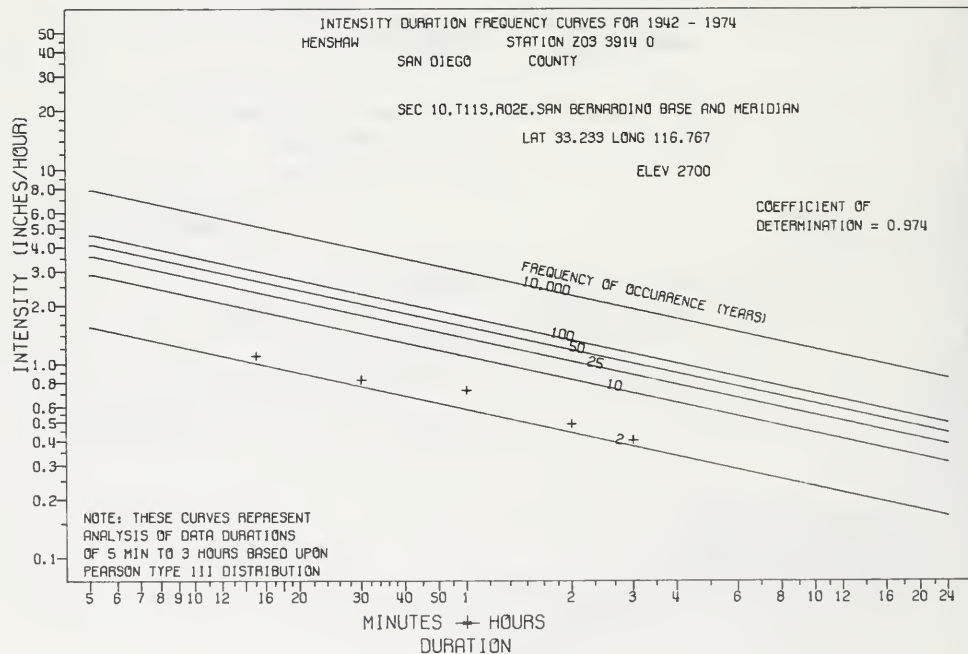
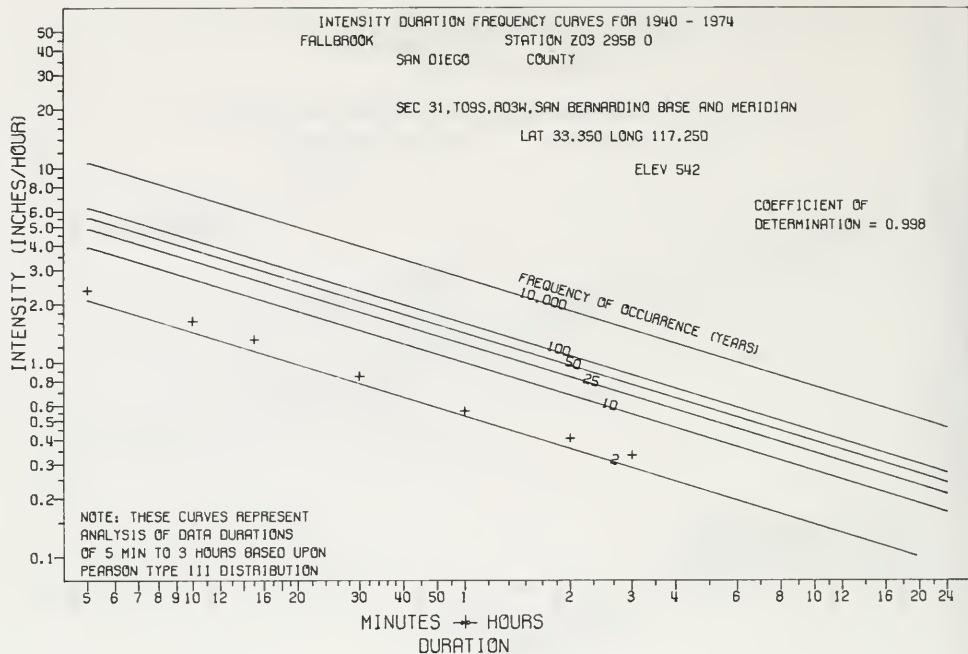












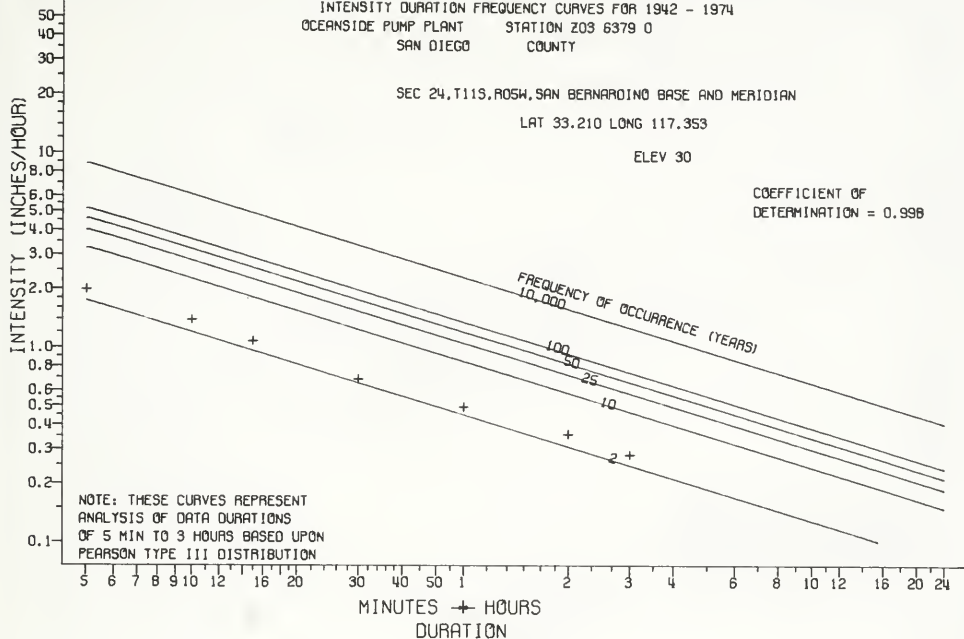
INTENSITY DURATION FREQUENCY CURVES FOR 1942 - 1974  
OCEANSIDE PUMP PLANT STATION 203 6379 0  
SAN DIEGO COUNTY

SEC 24, T11S, R05W, SAN BERNARDINO BASE AND MERIDIAN

LAT 33.210 LONG 117.353

ELEV 30

COEFFICIENT OF  
DETERMINATION = 0.998

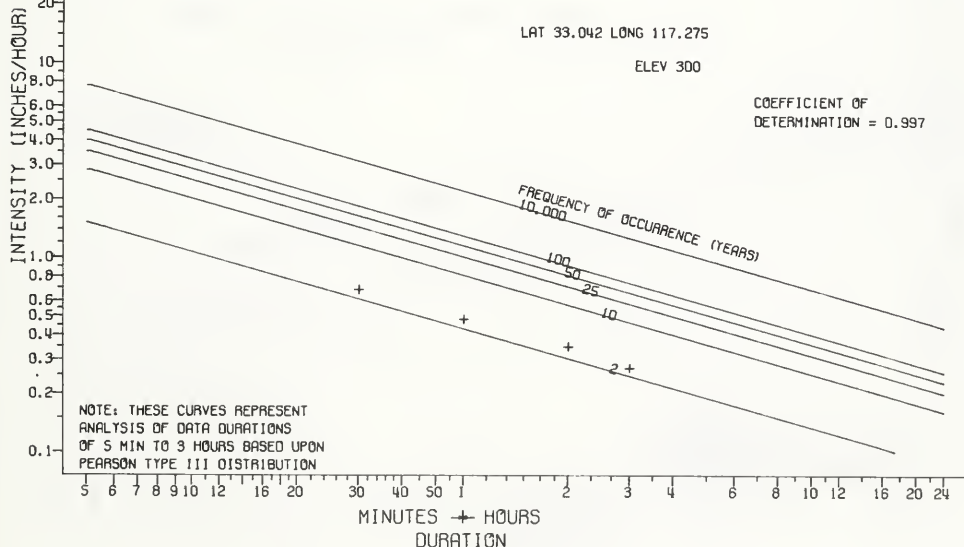


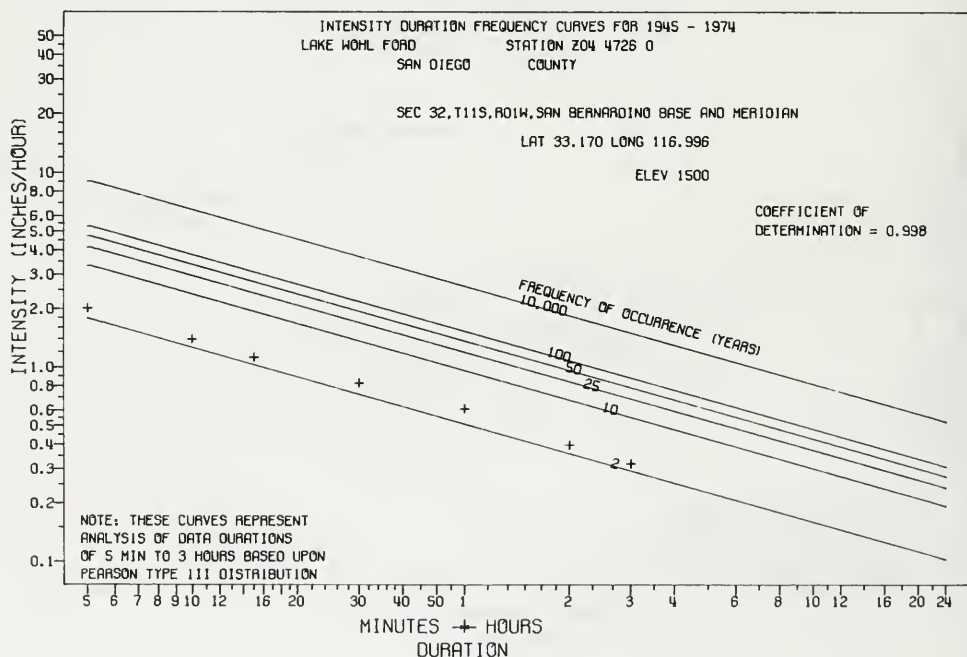
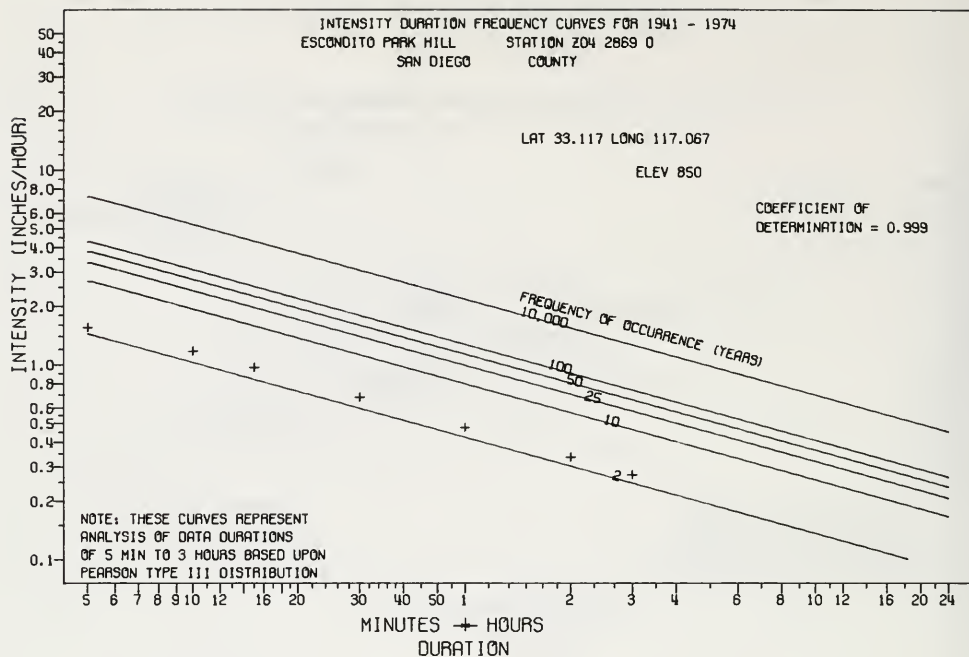
INTENSITY DURATION FREQUENCY CURVES FOR 1964 - 1975  
ENCINITAS STATION 204 2833 10  
SAN DIEGO COUNTY

LAT 33.042 LONG 117.275

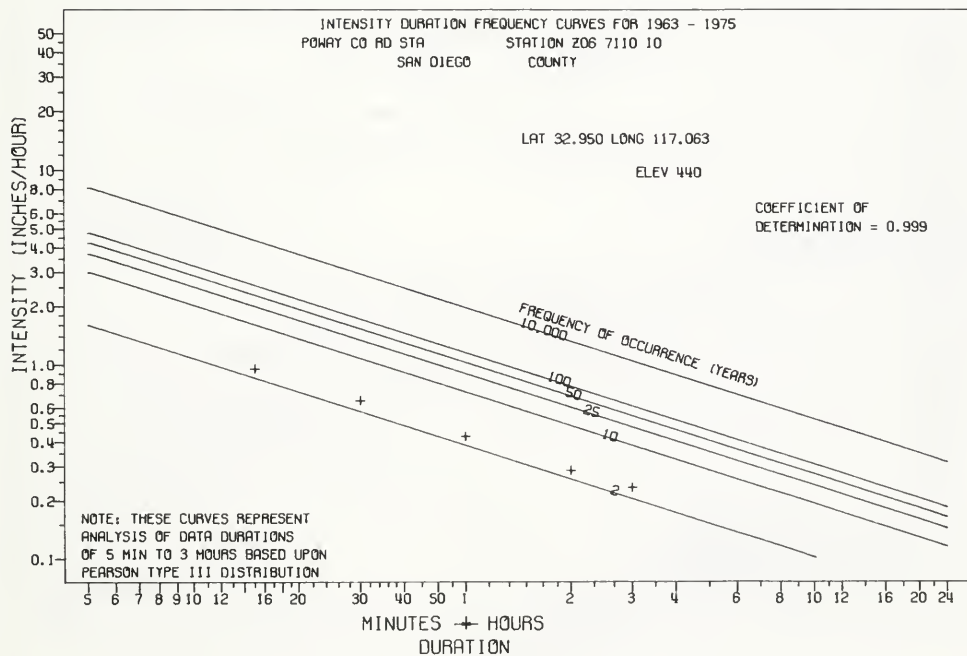
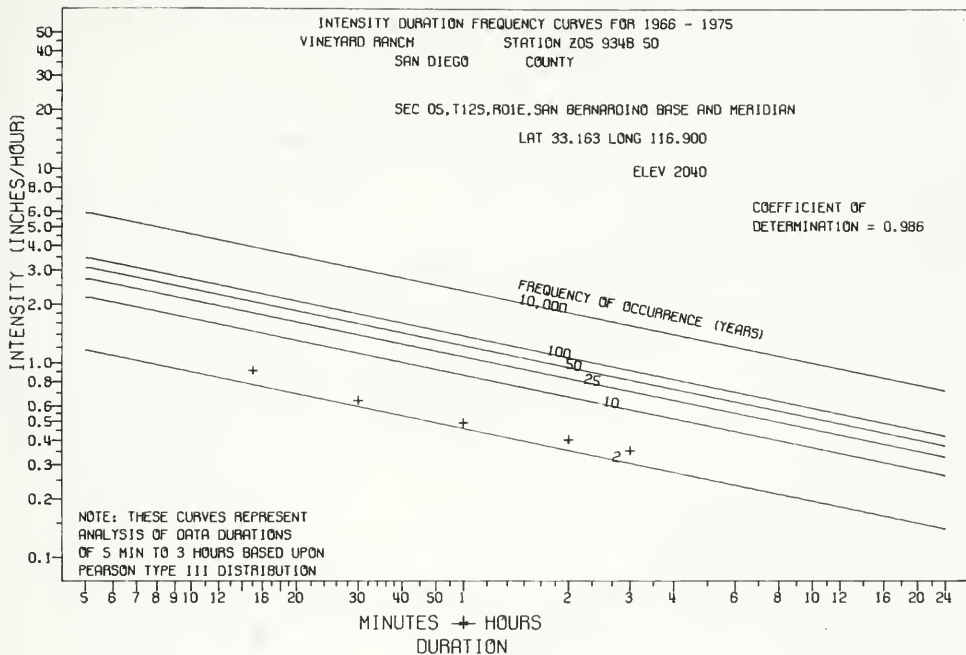
ELEV 300

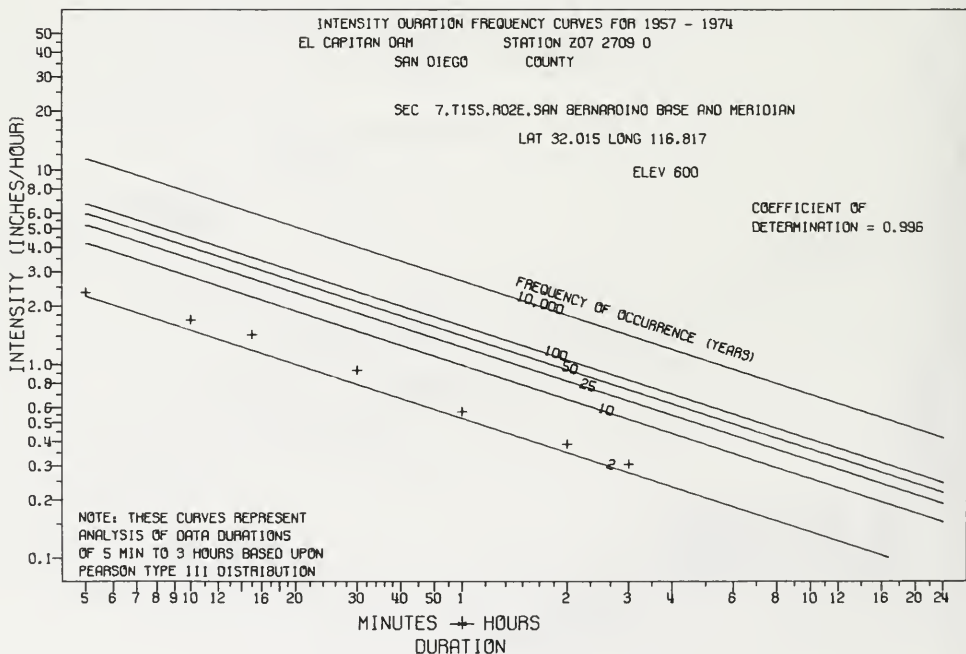
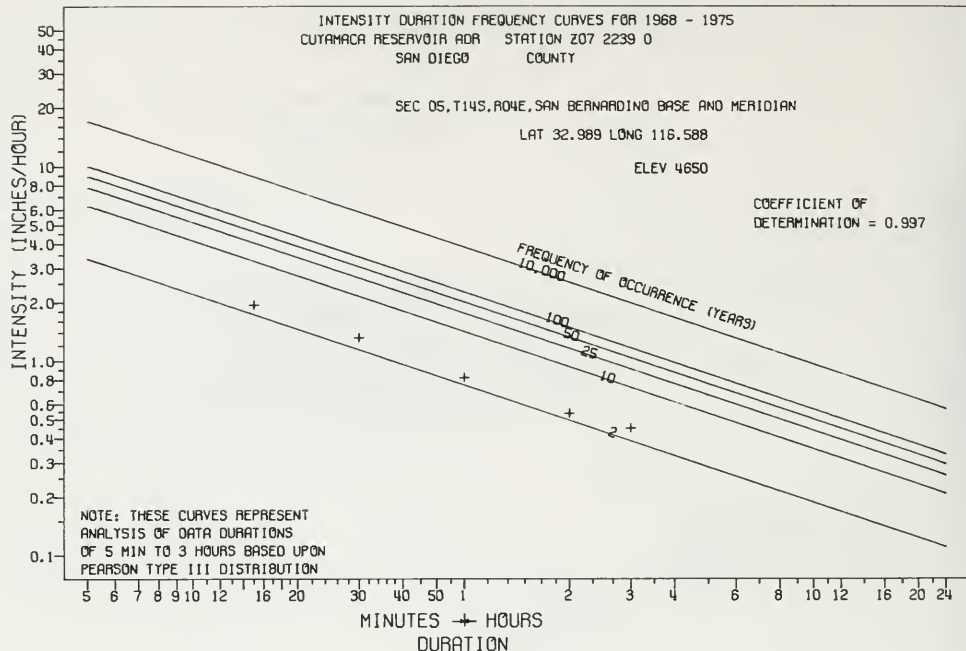
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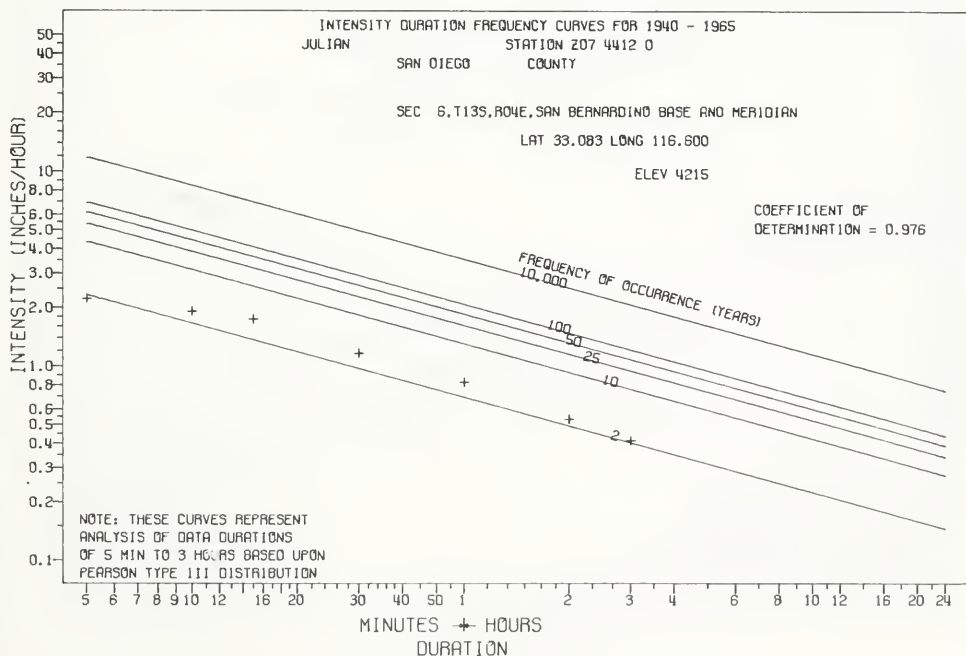
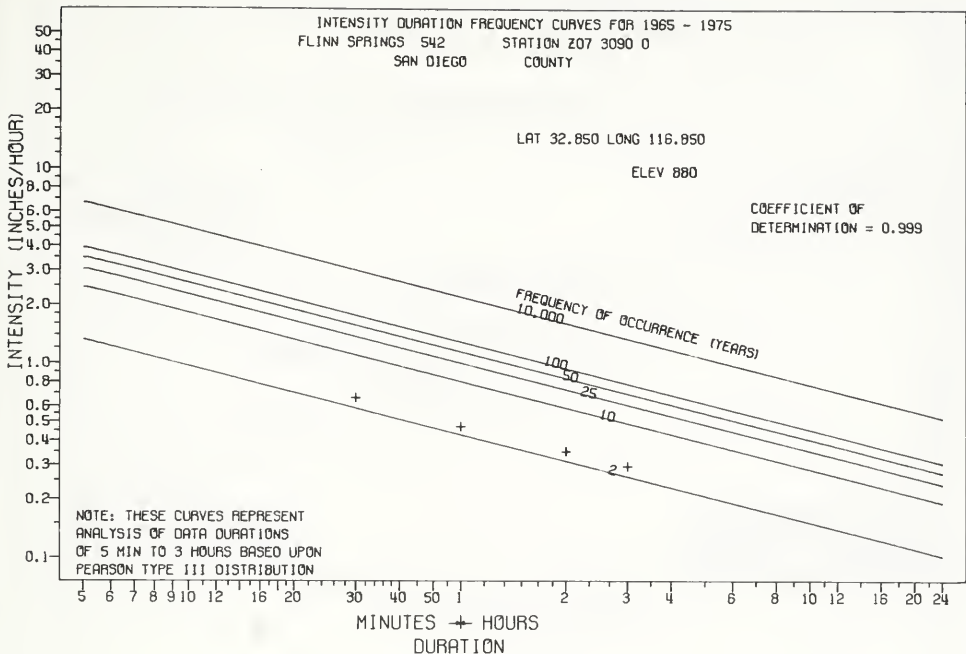


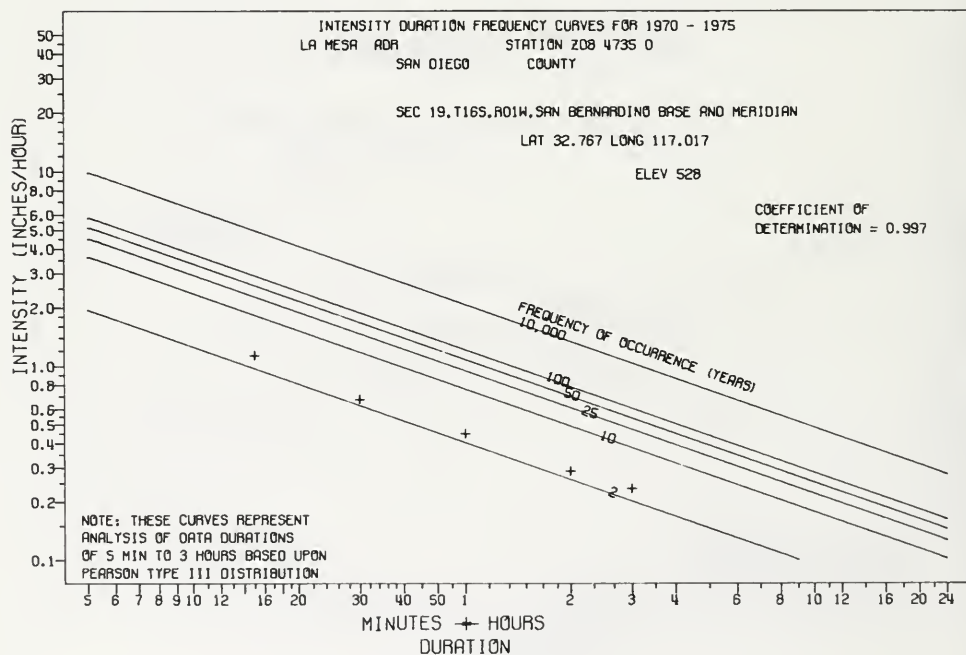
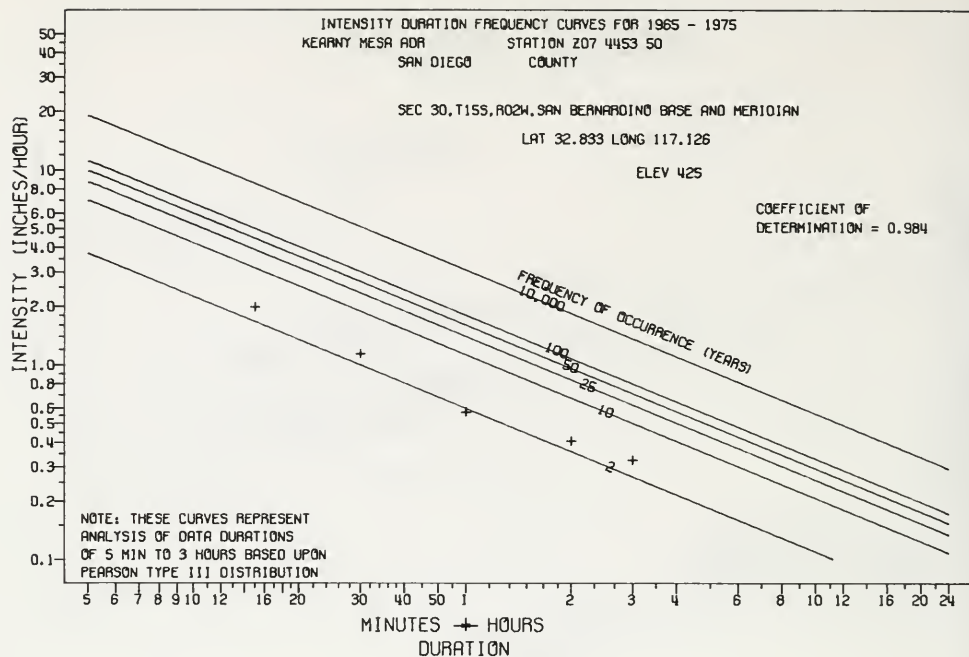


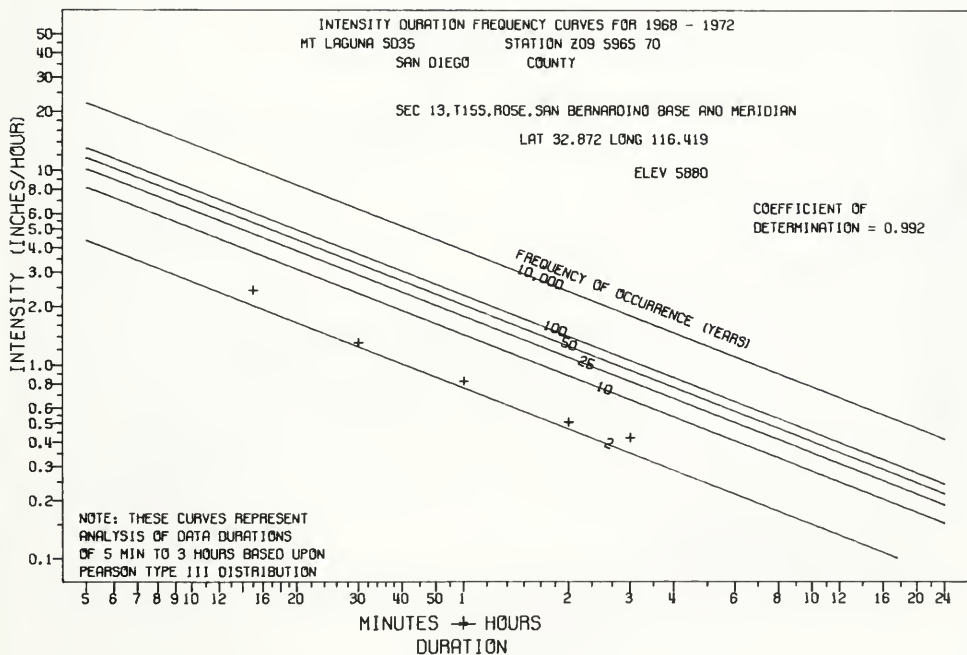
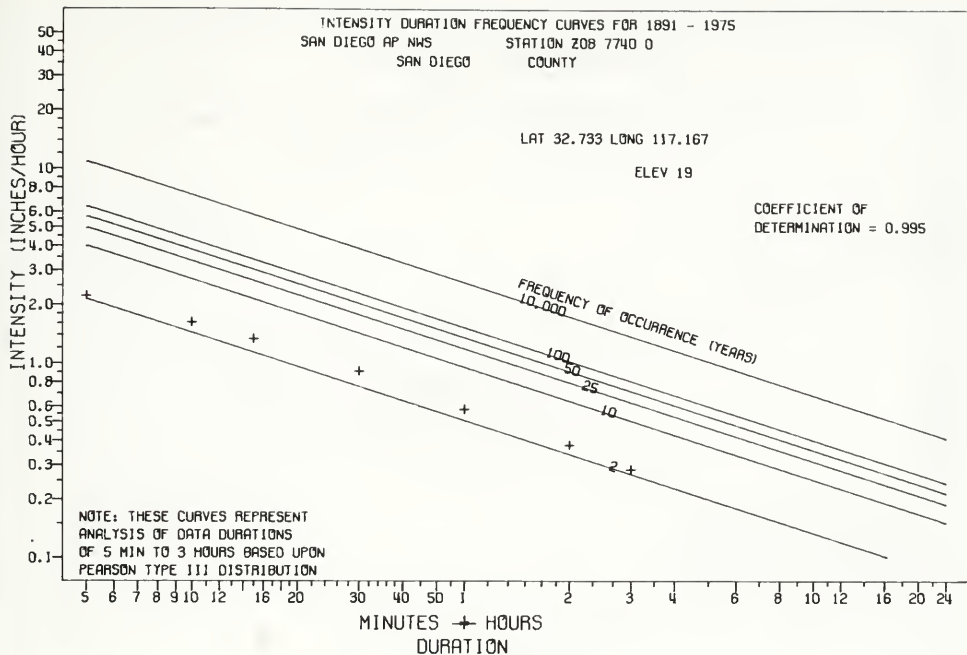


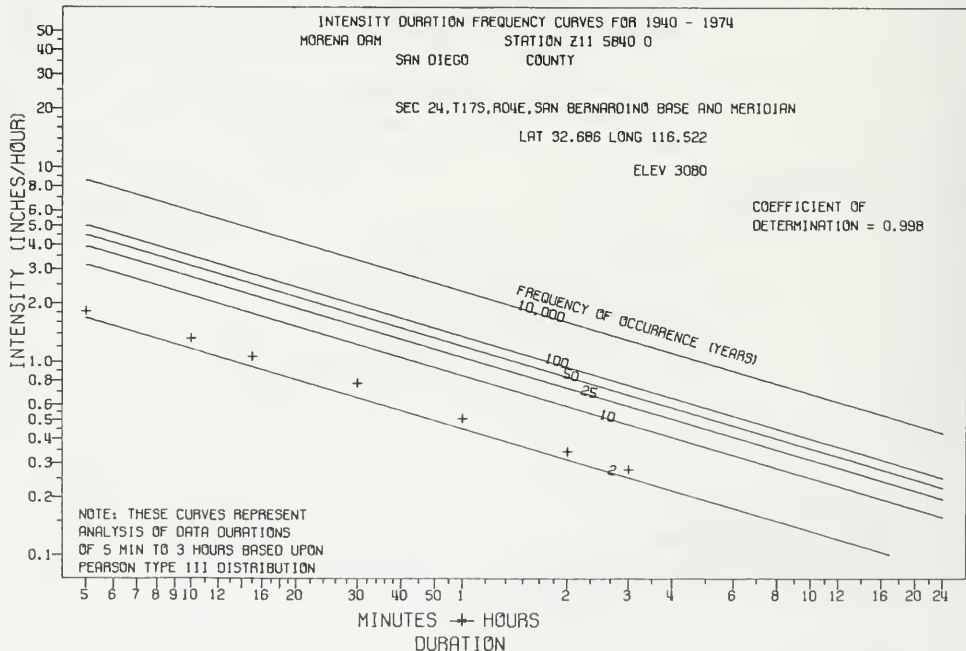
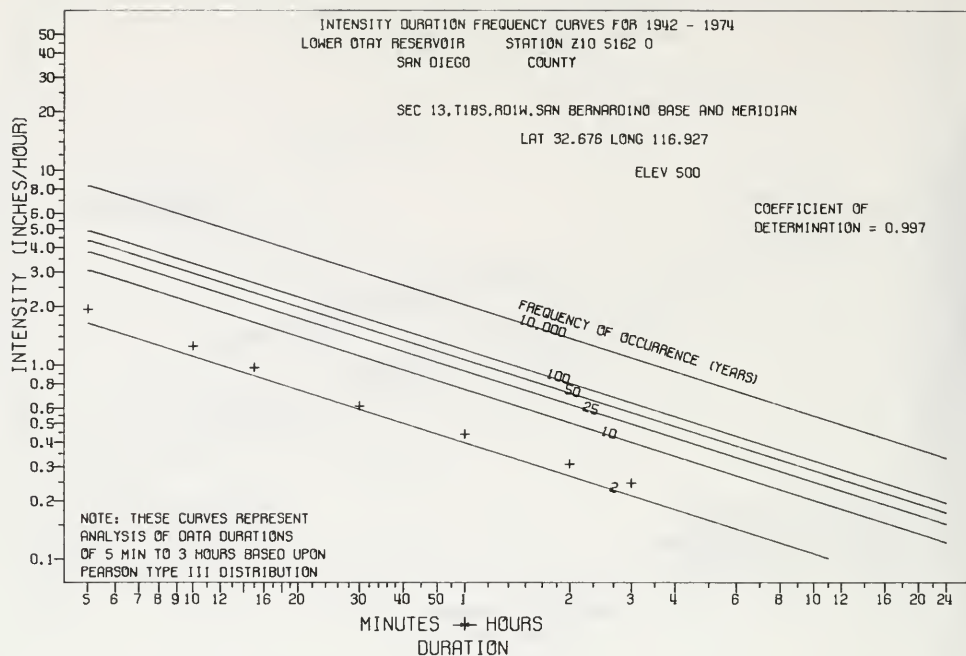


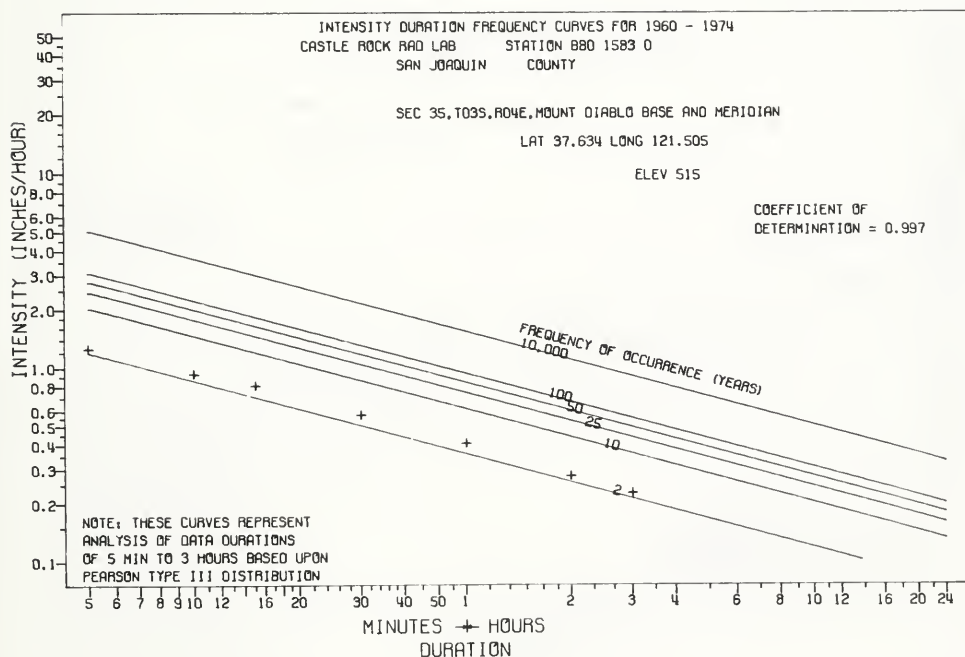
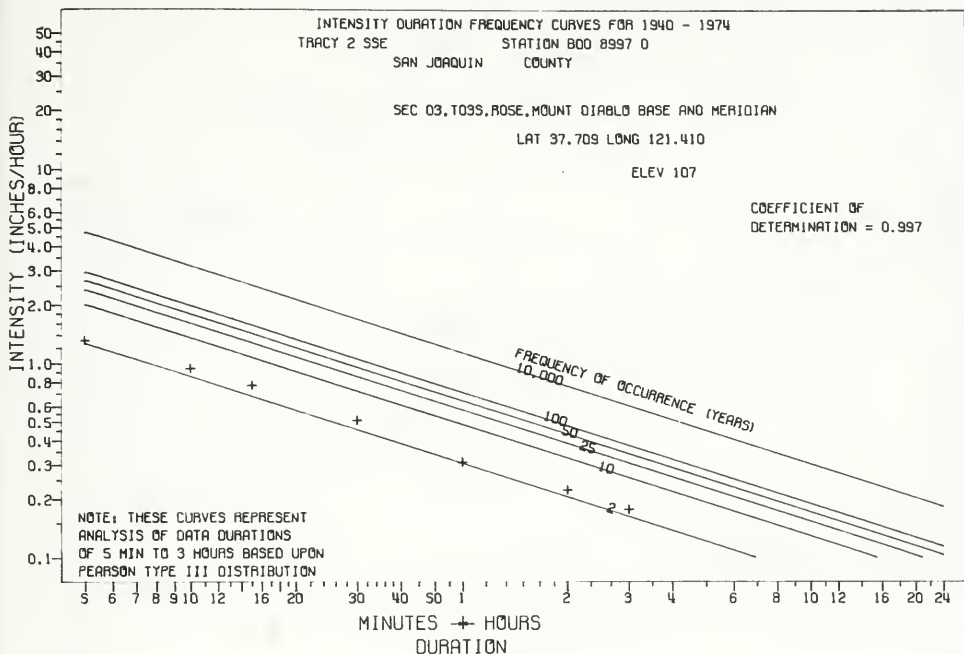




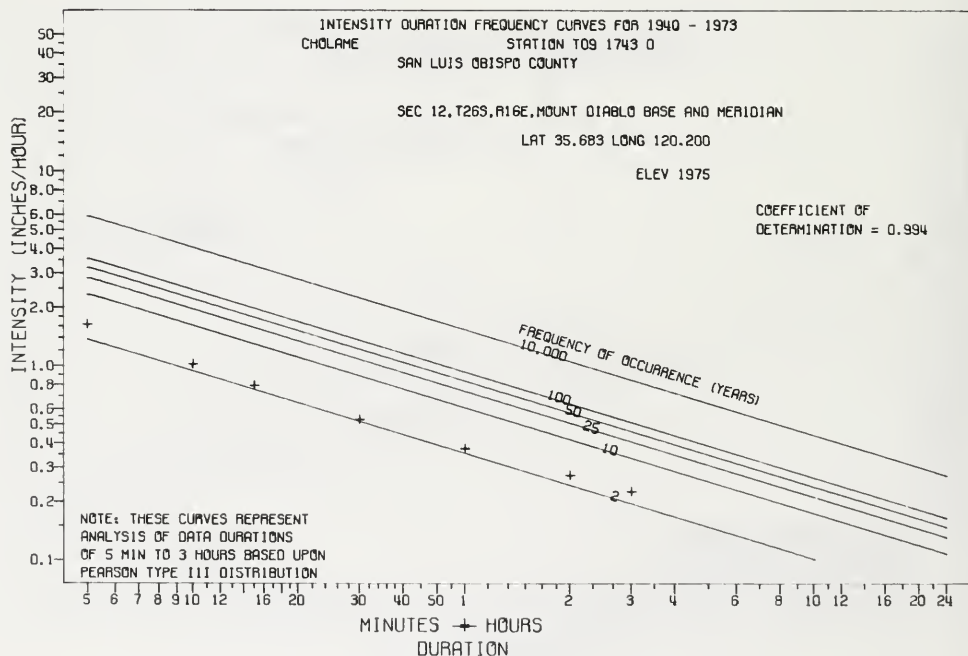
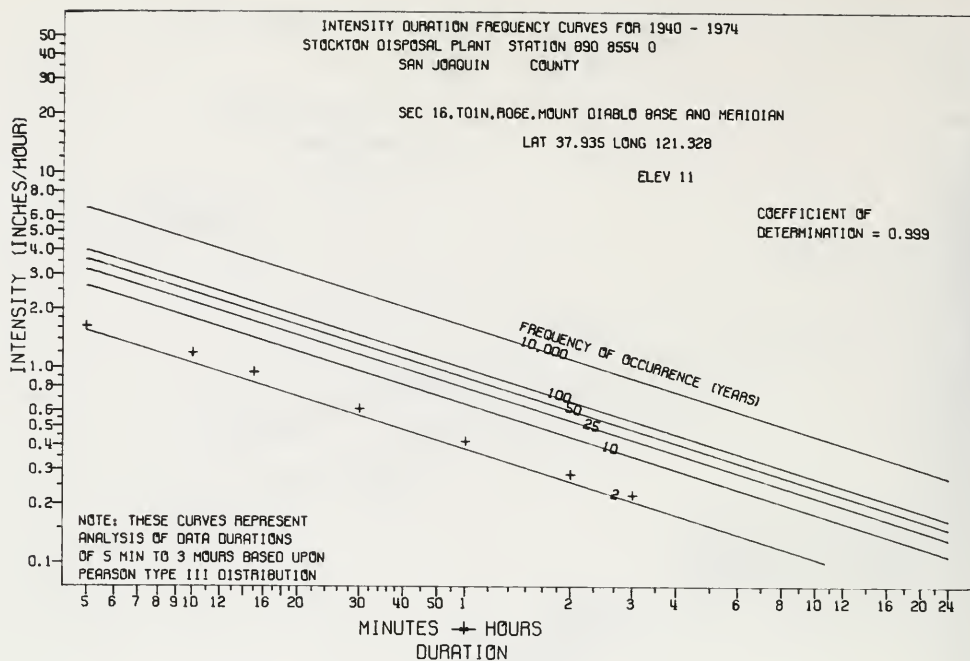




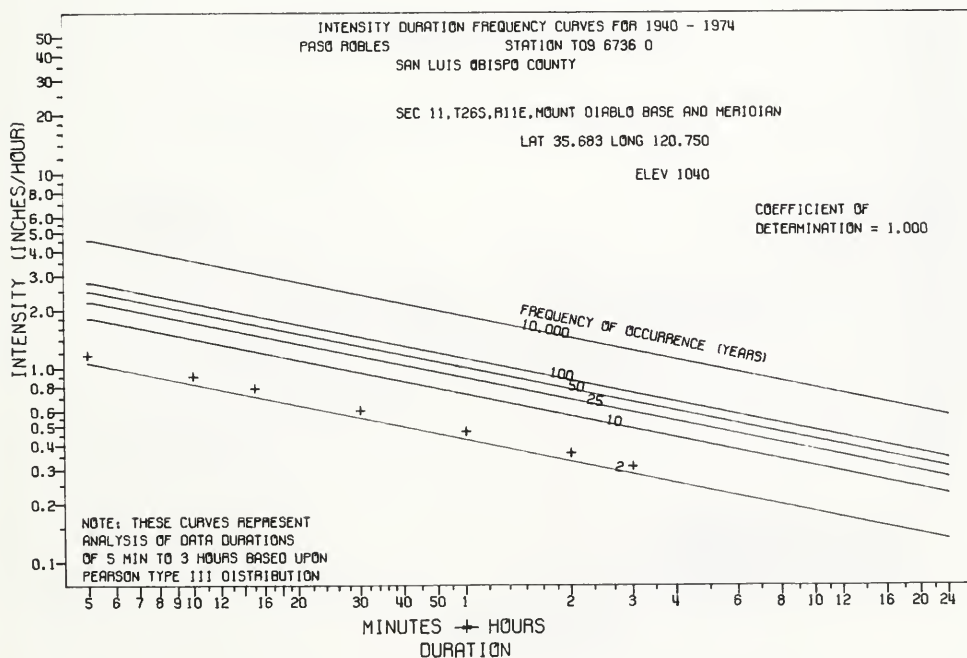
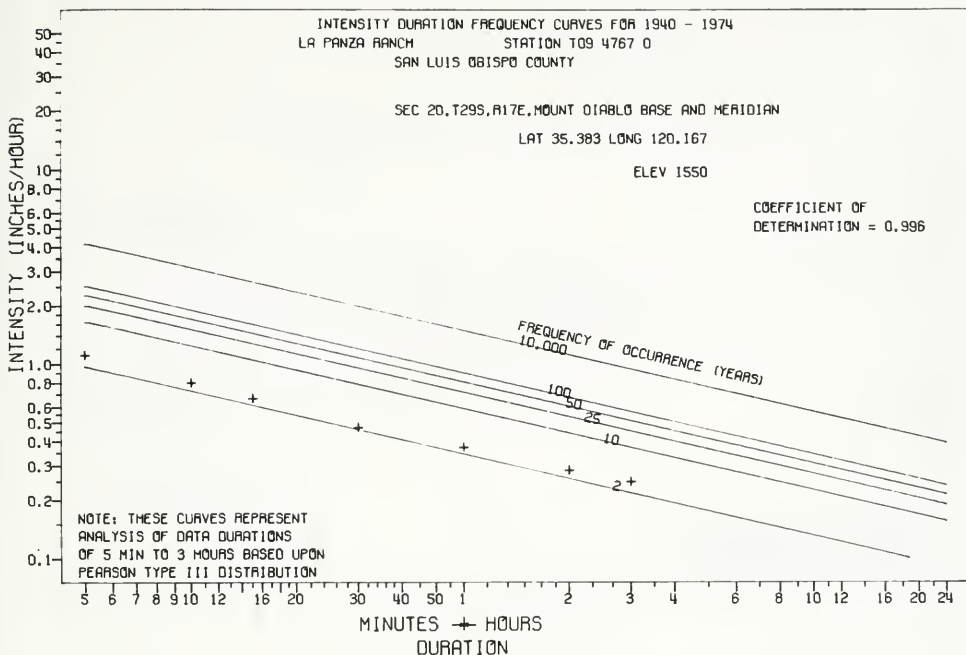


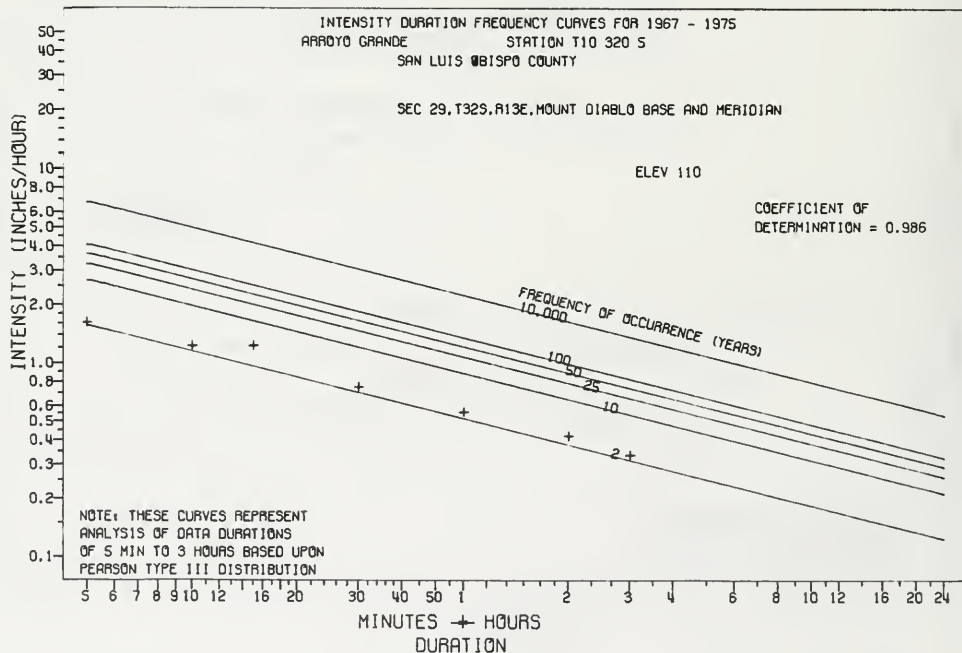
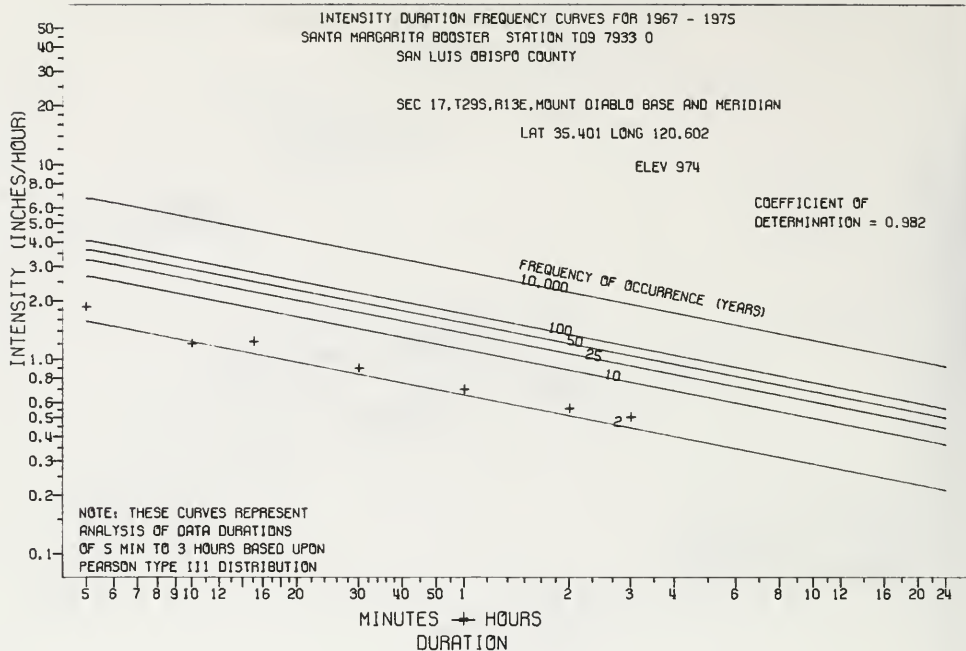


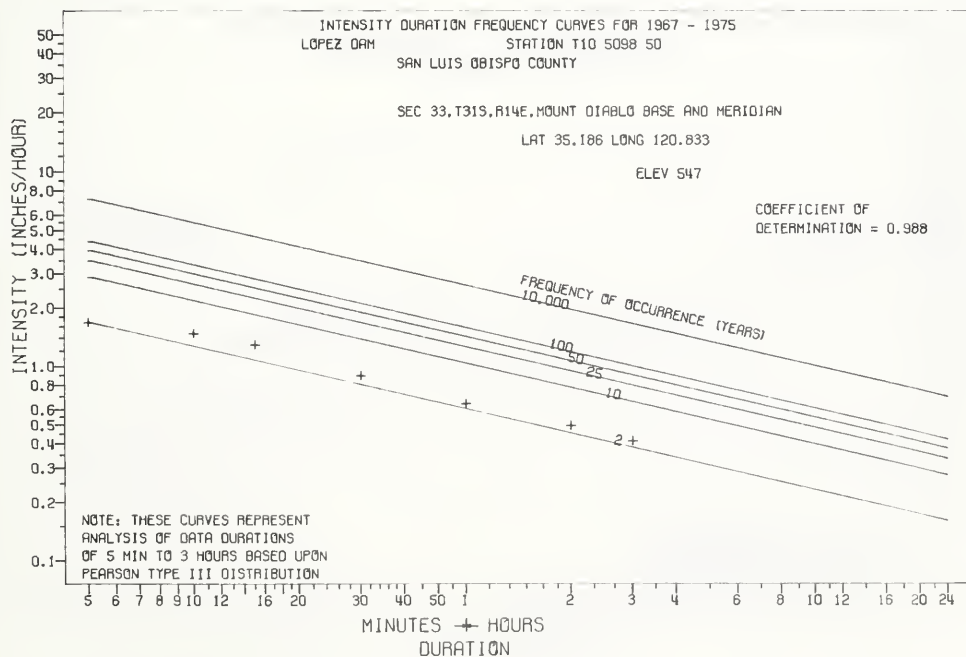
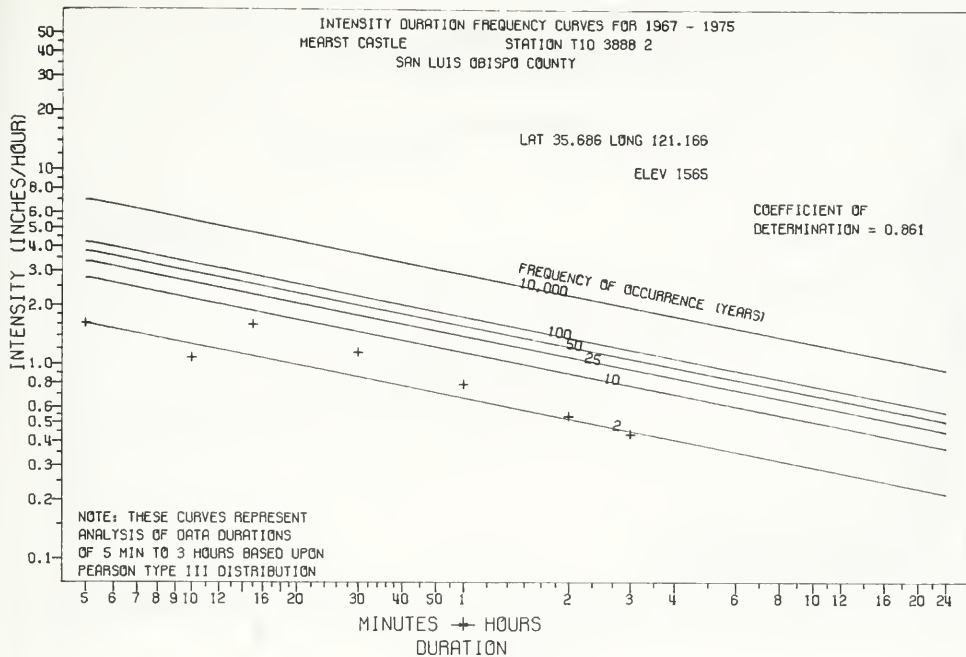


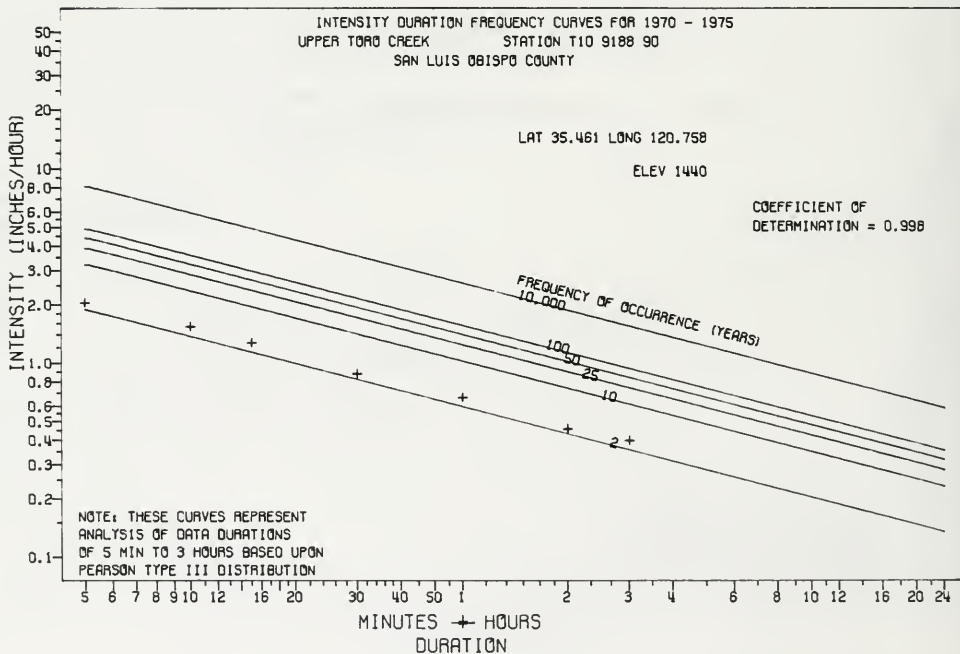
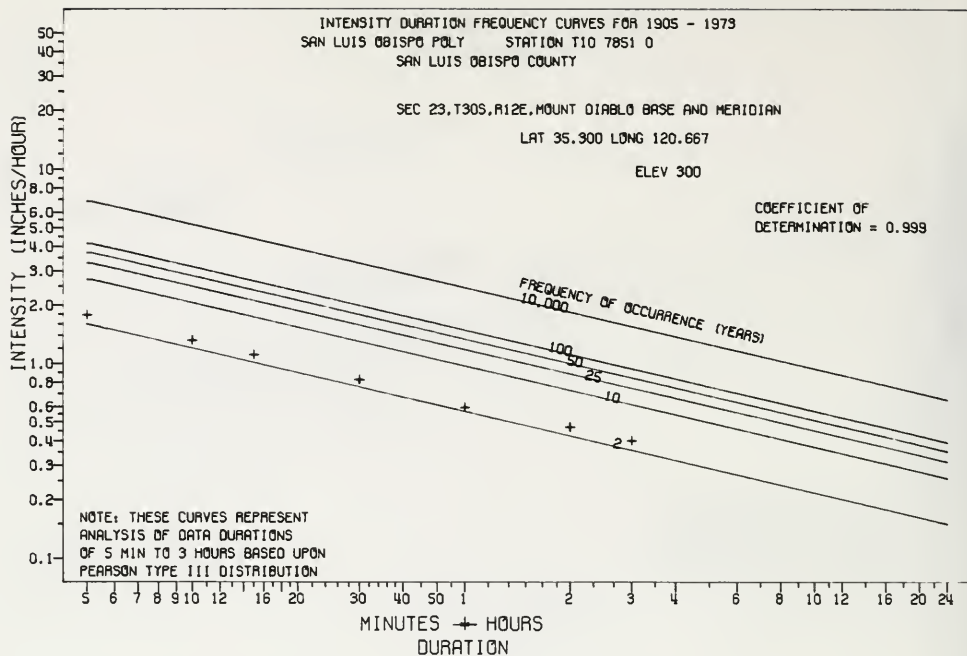


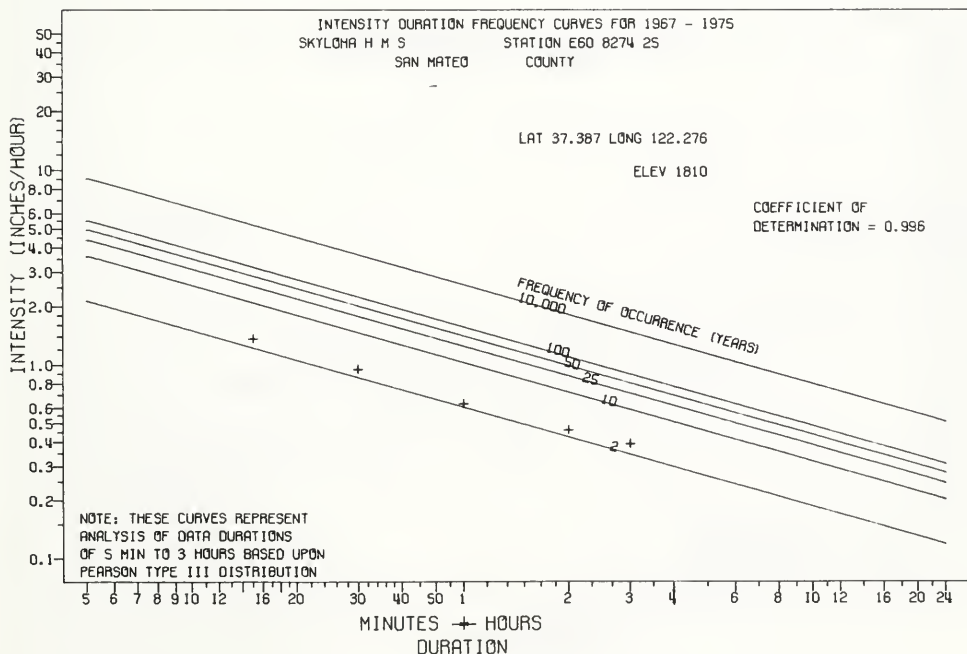
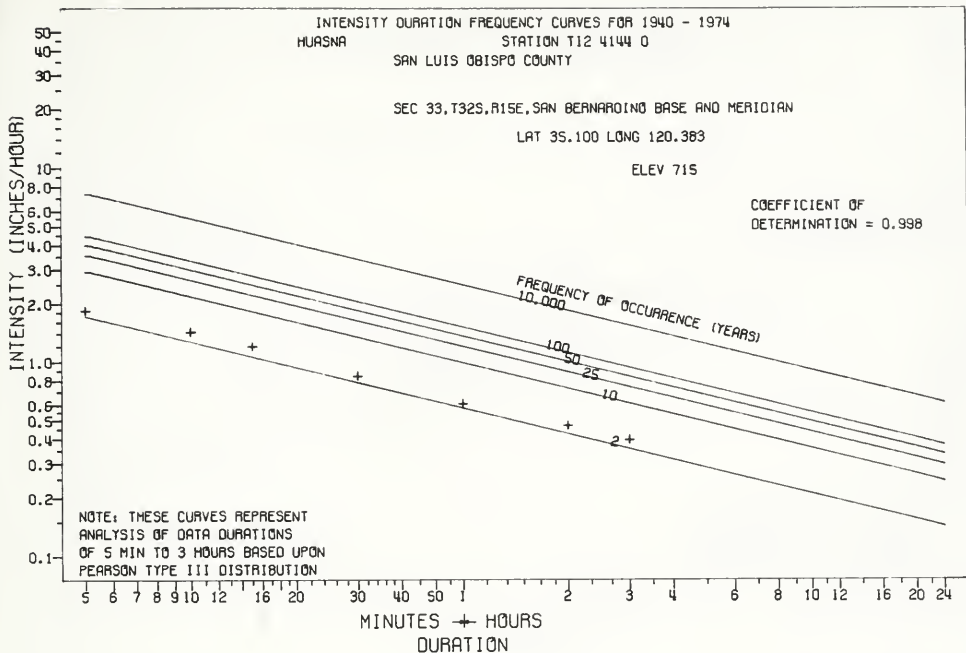


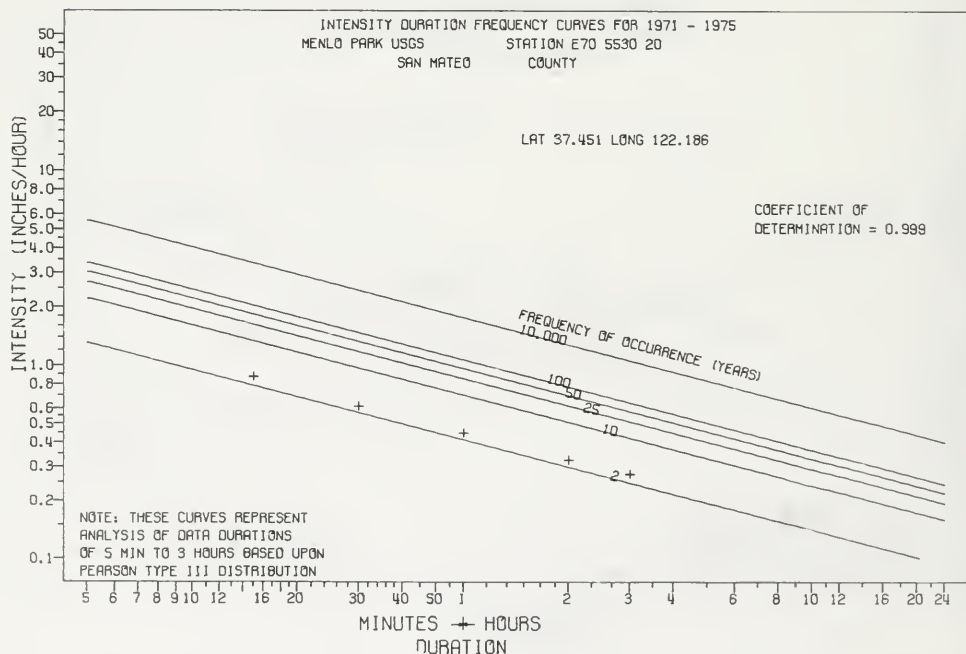
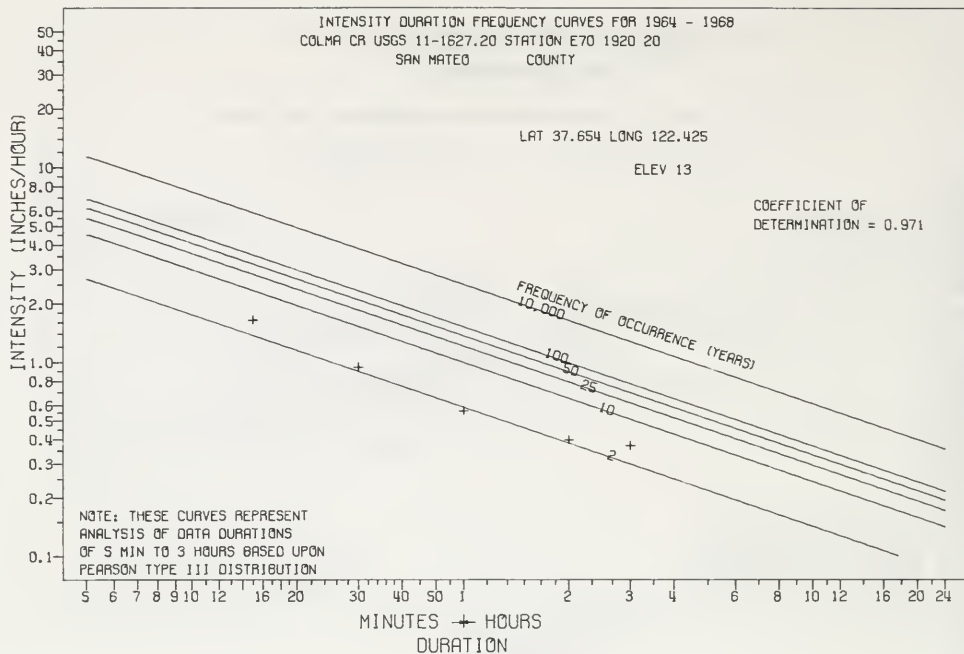


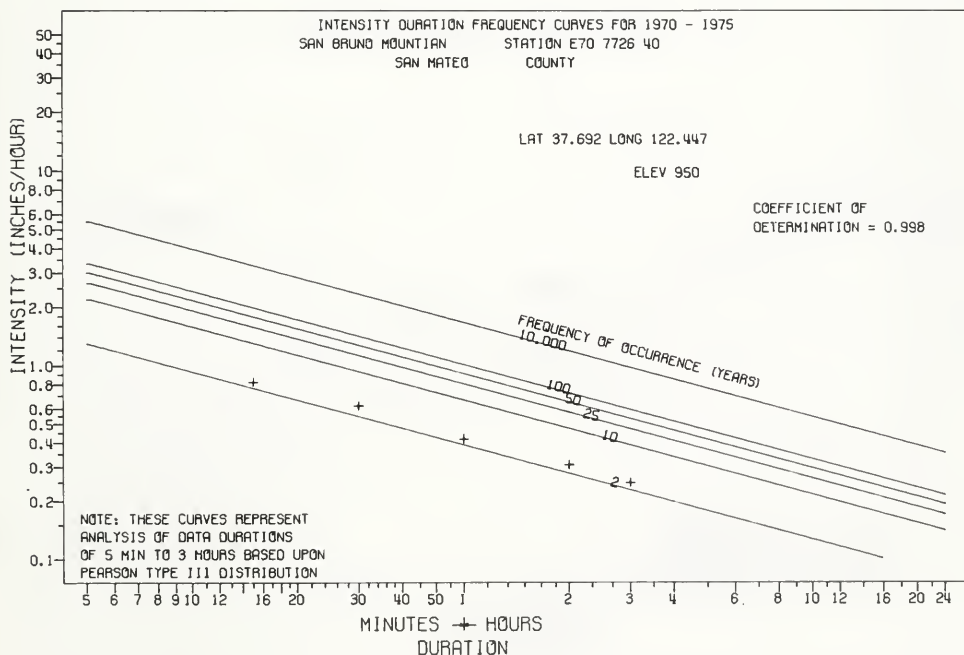
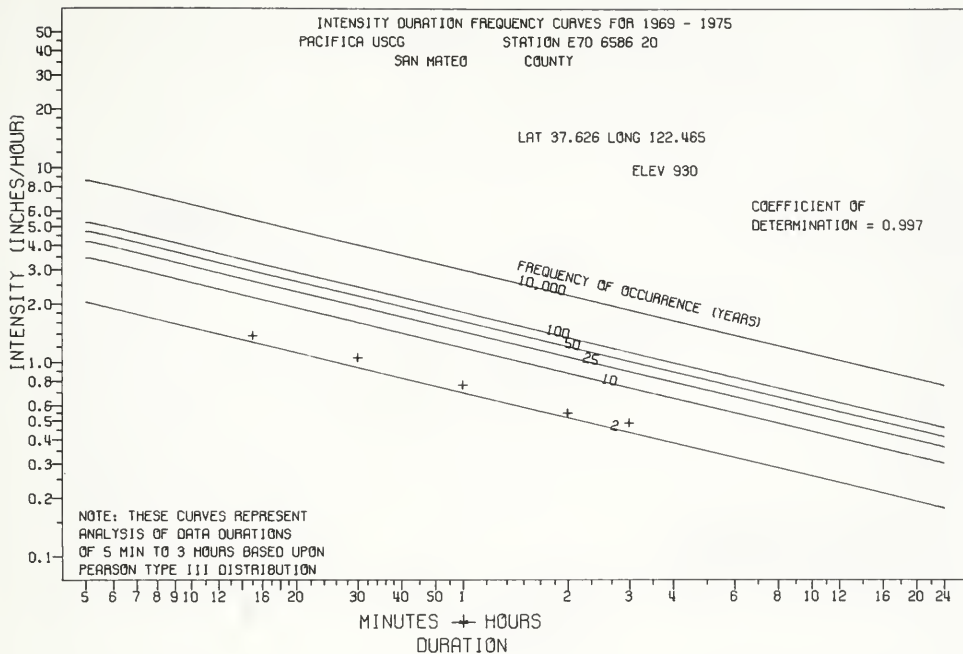


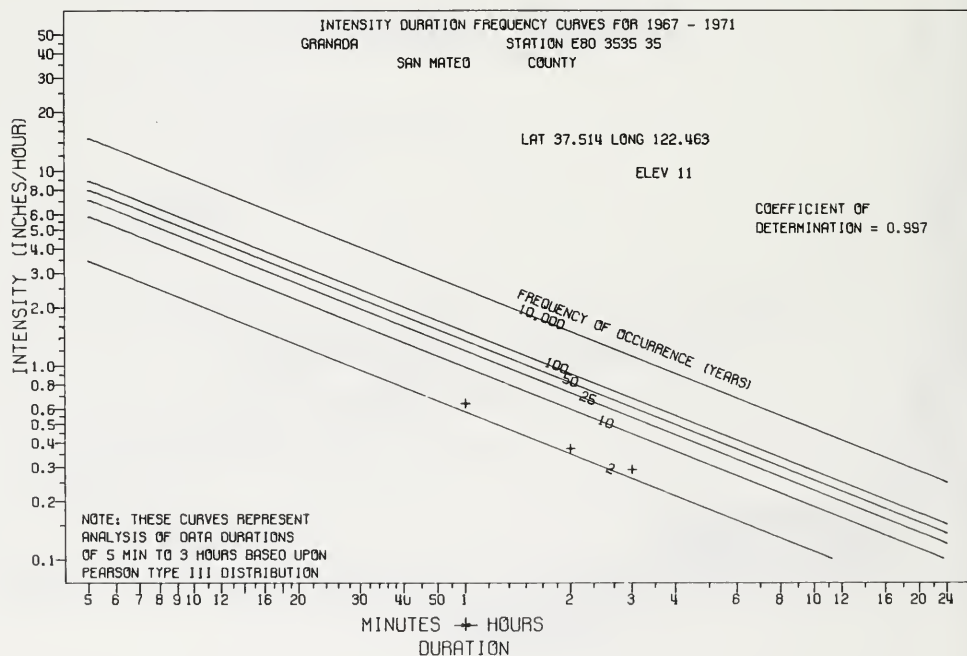
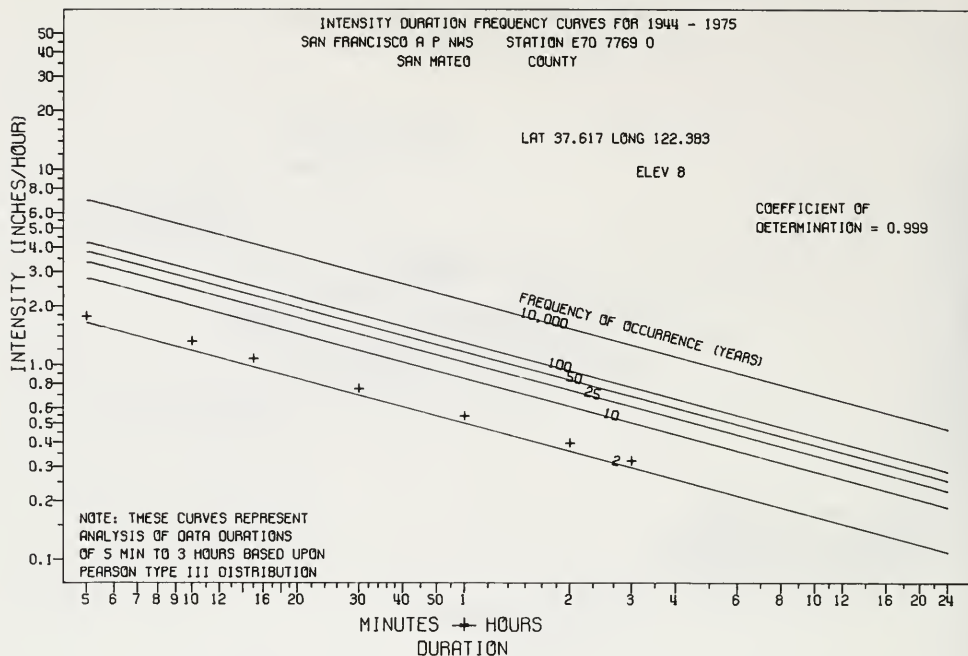




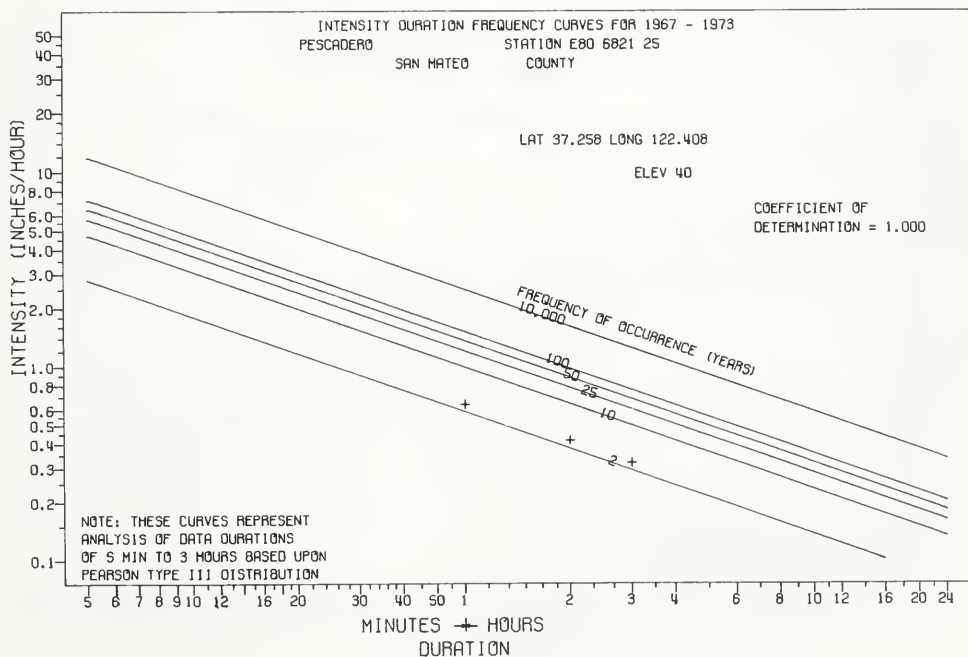
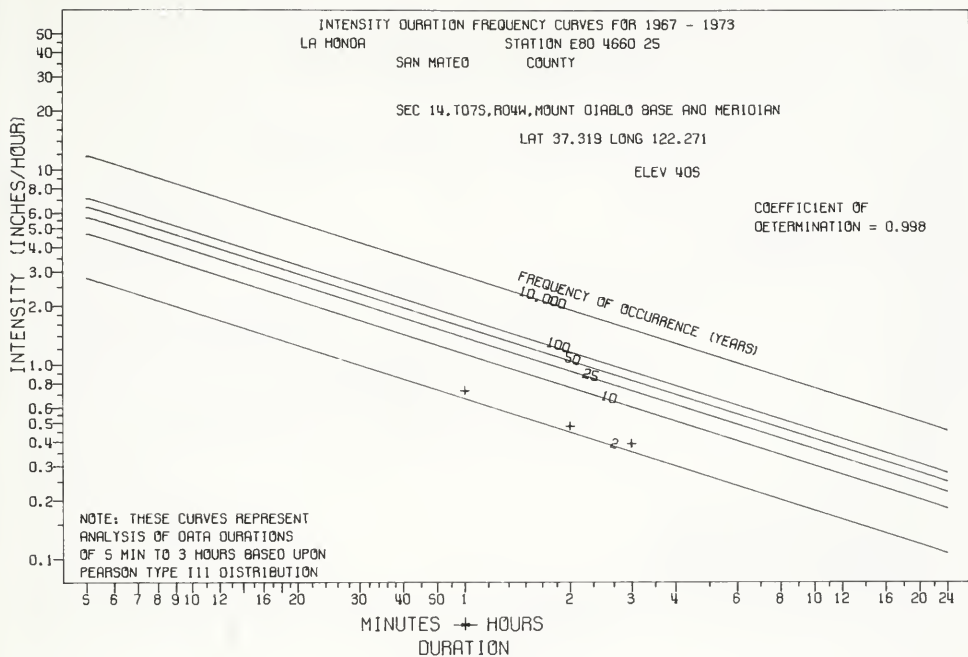


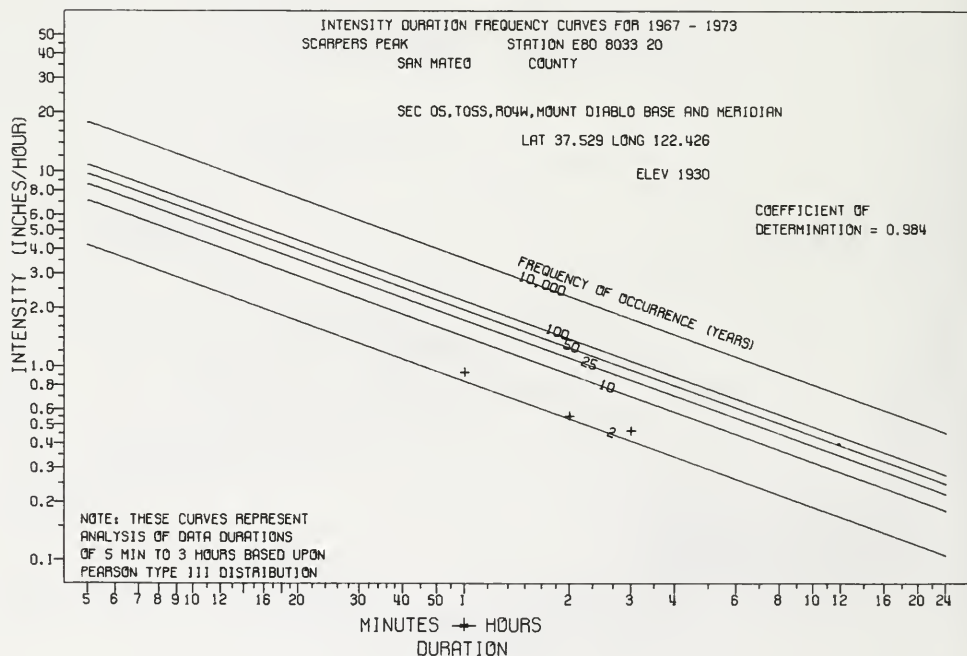
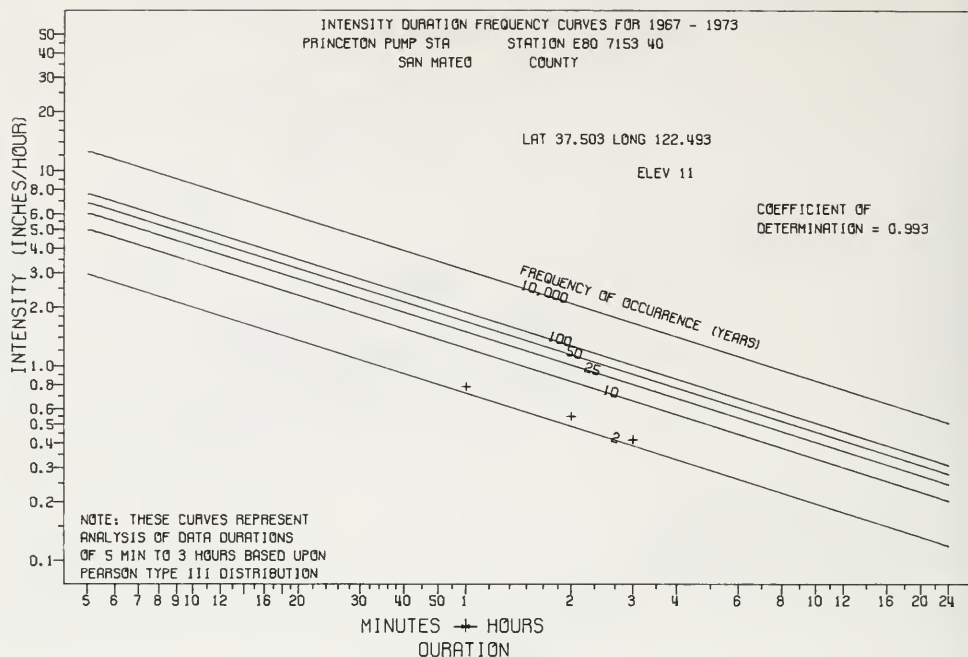


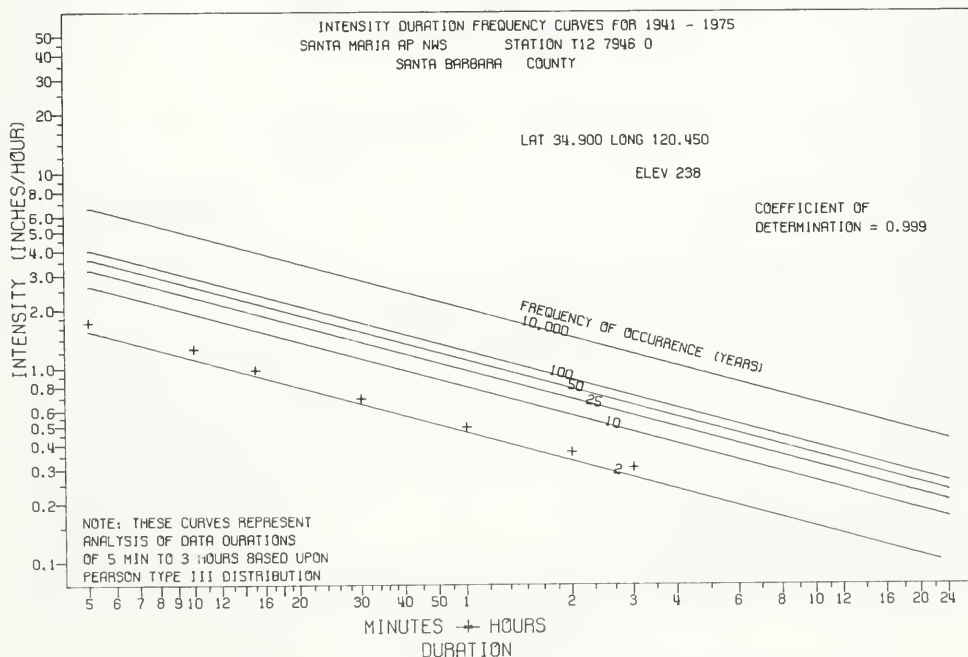
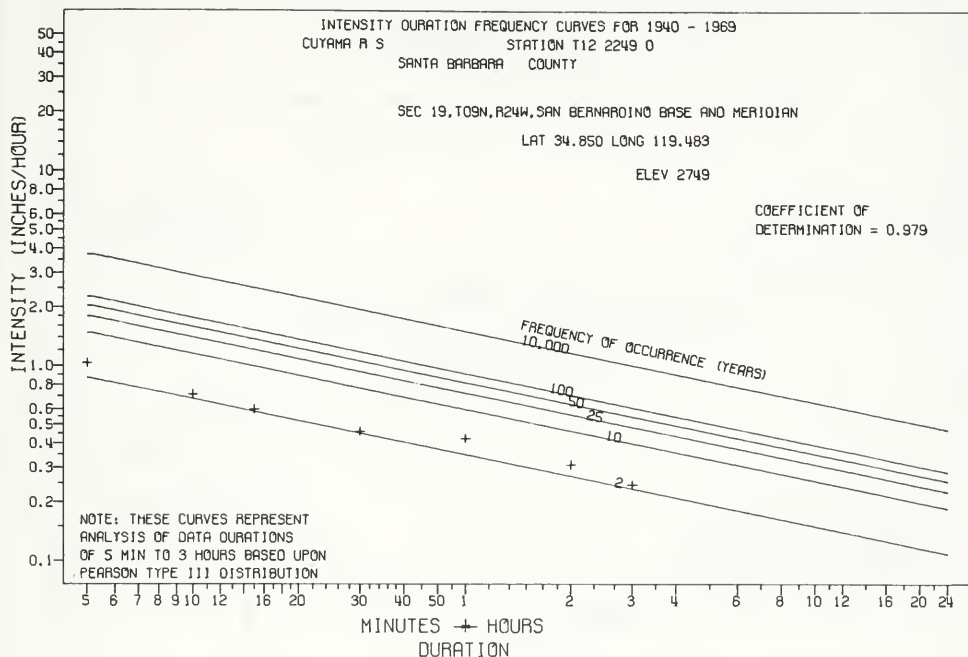


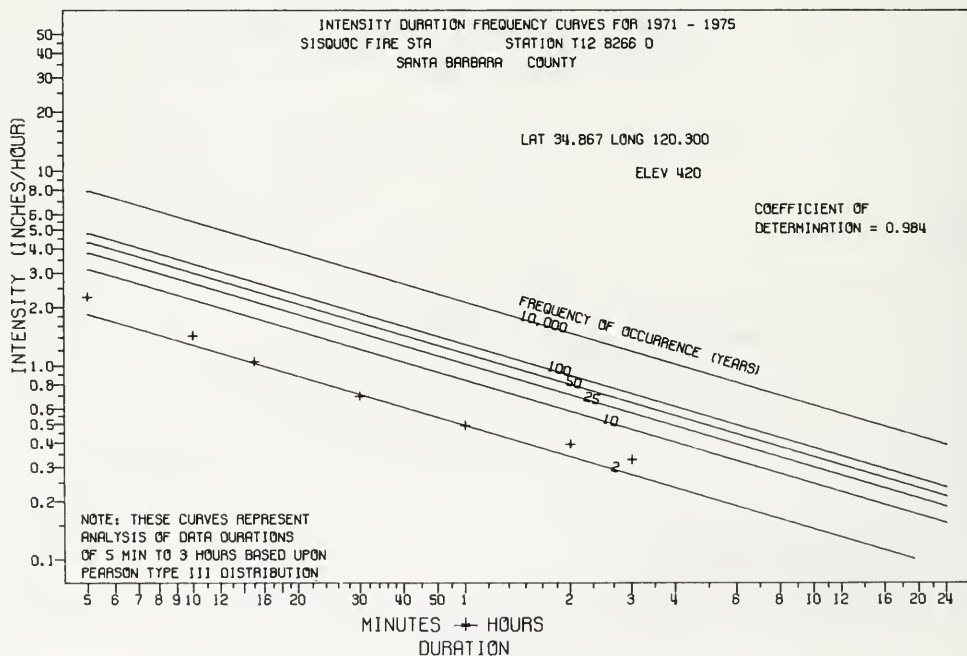
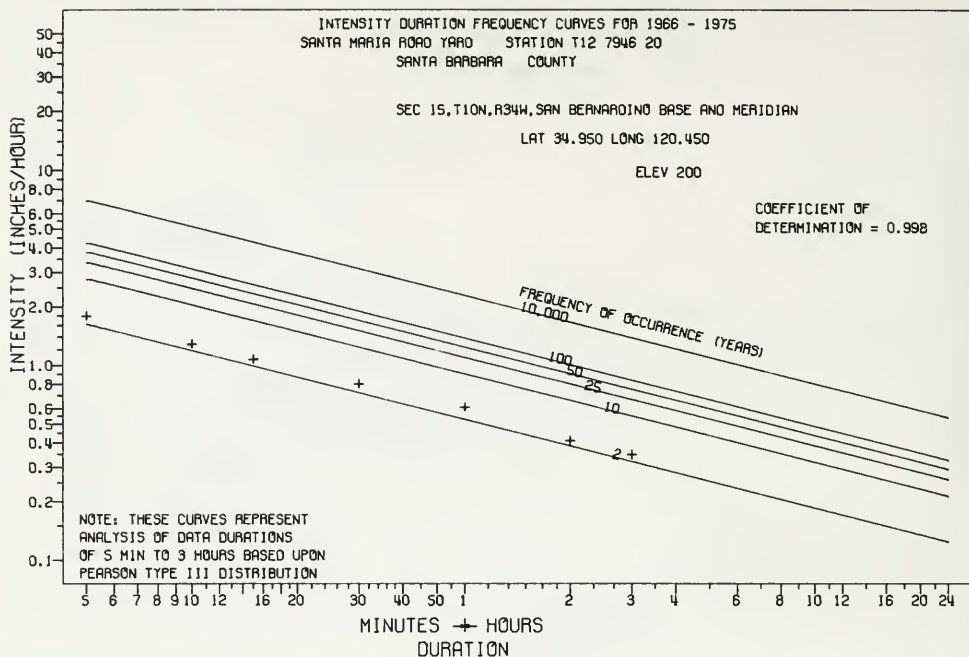


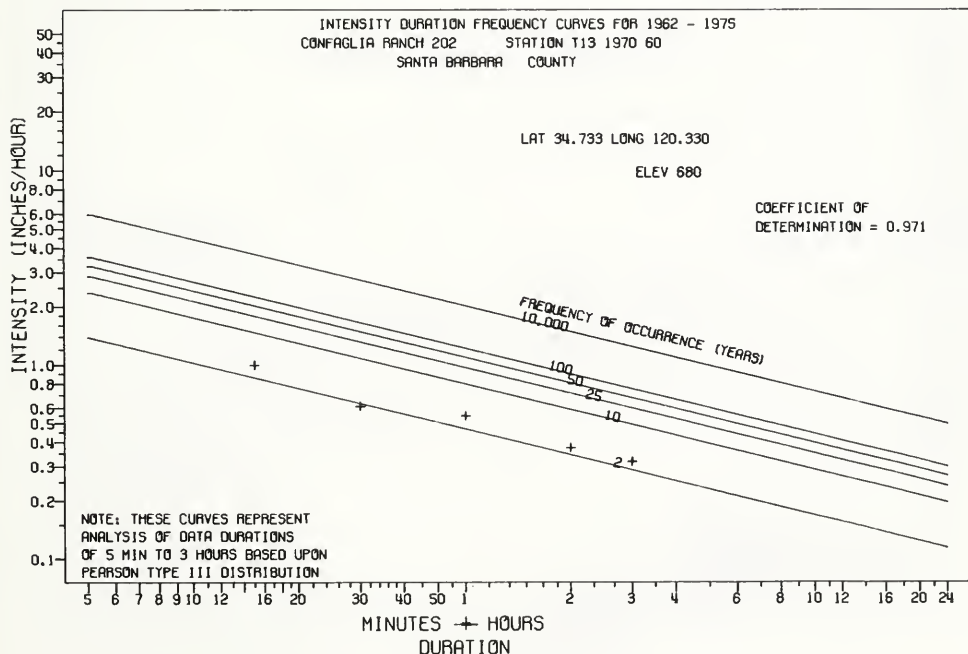
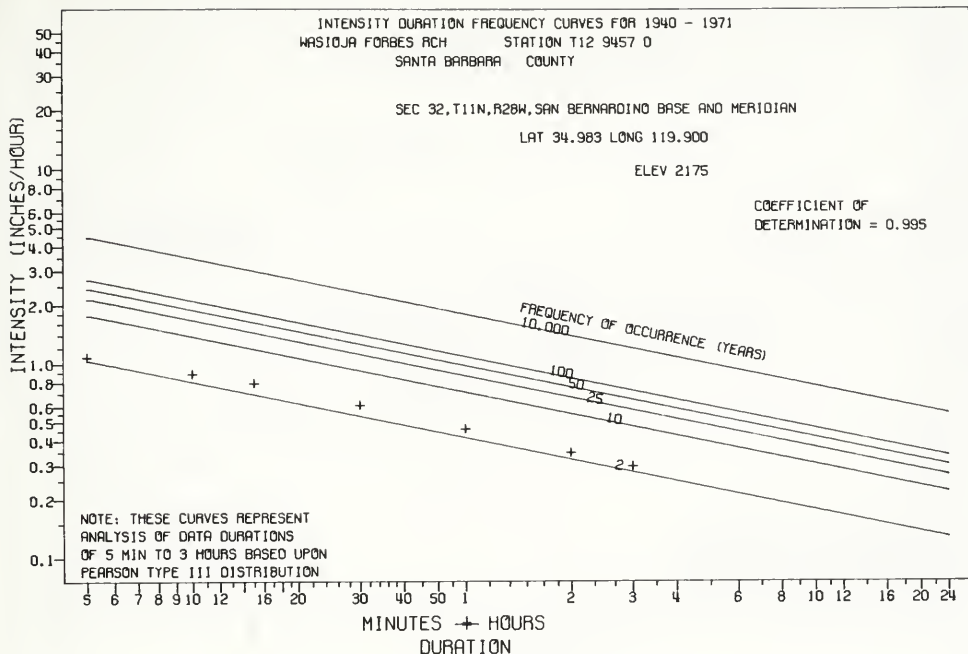


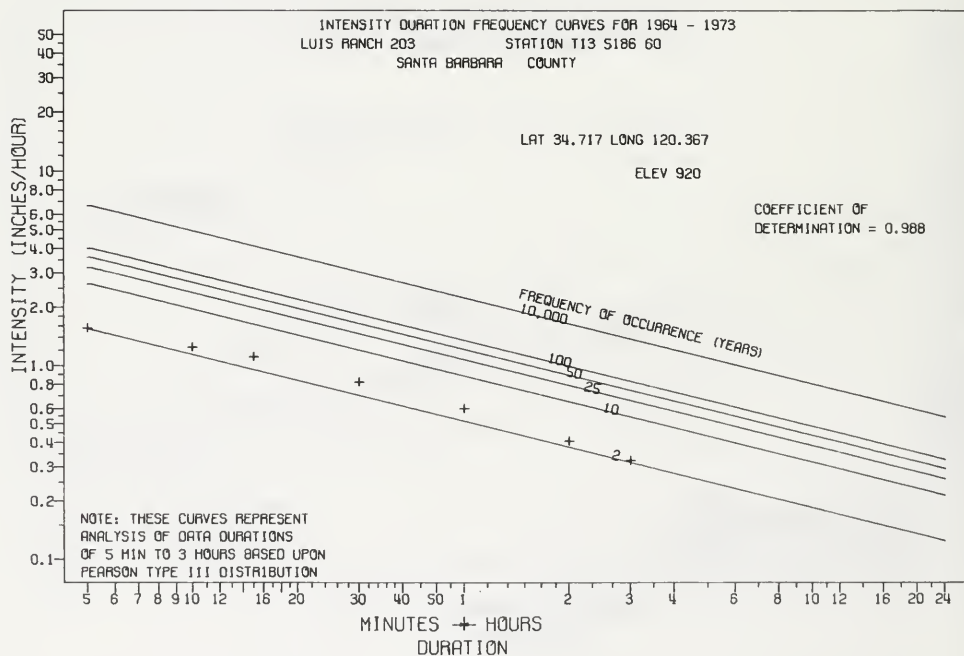
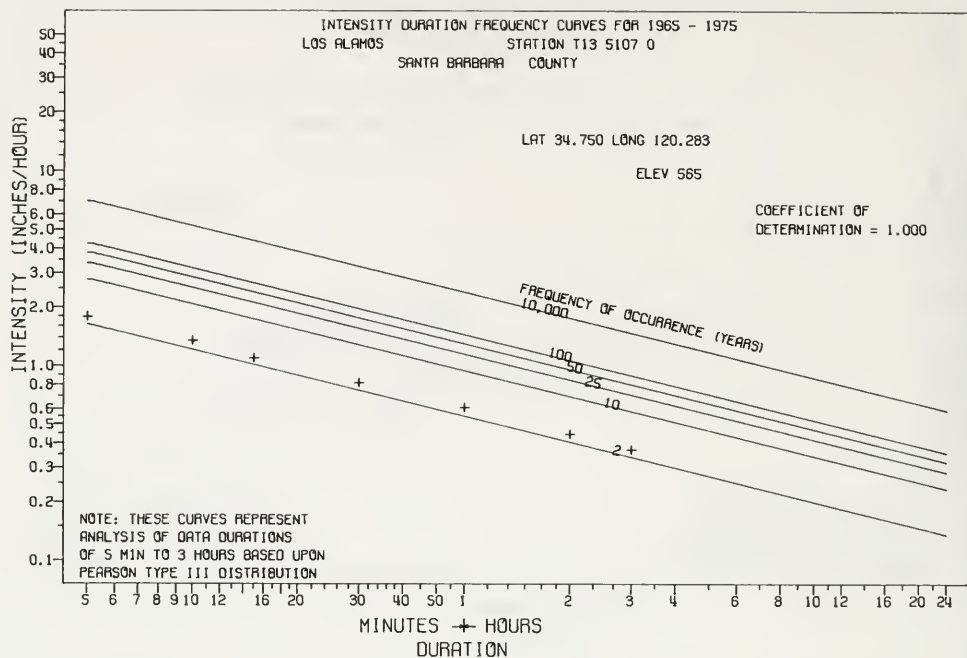


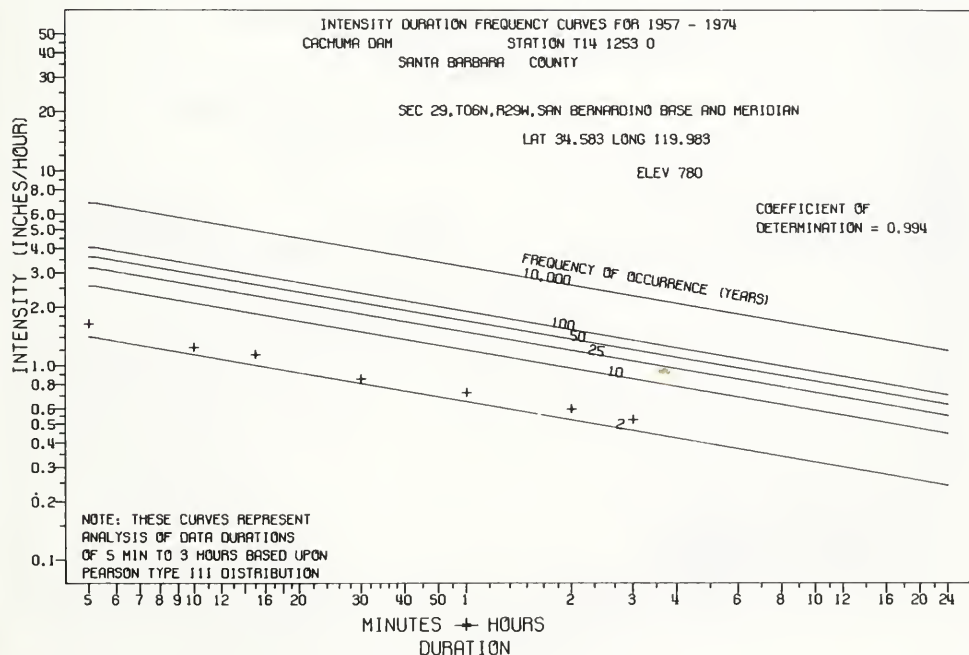
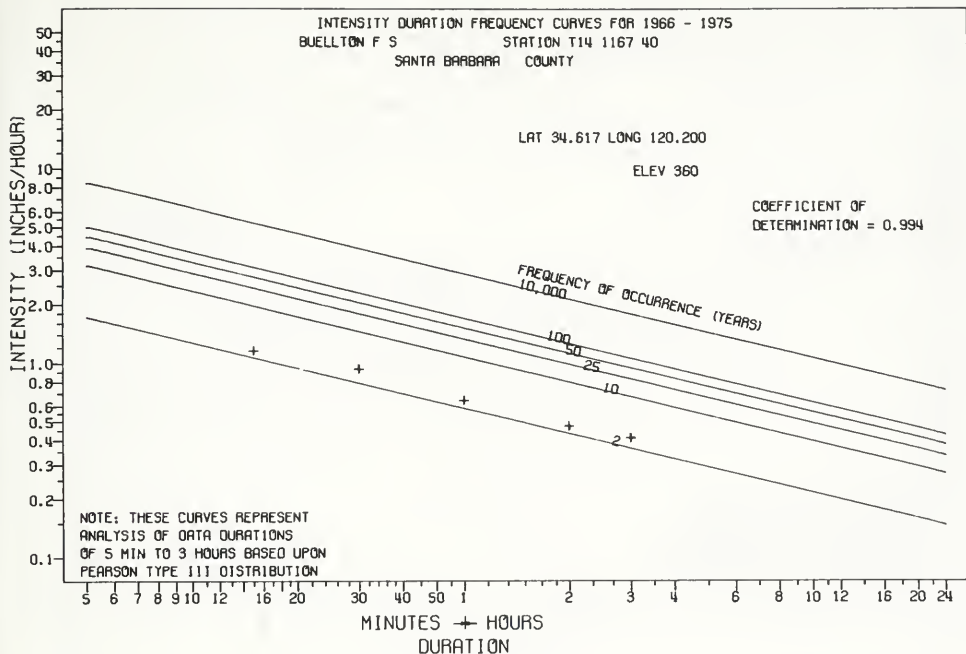


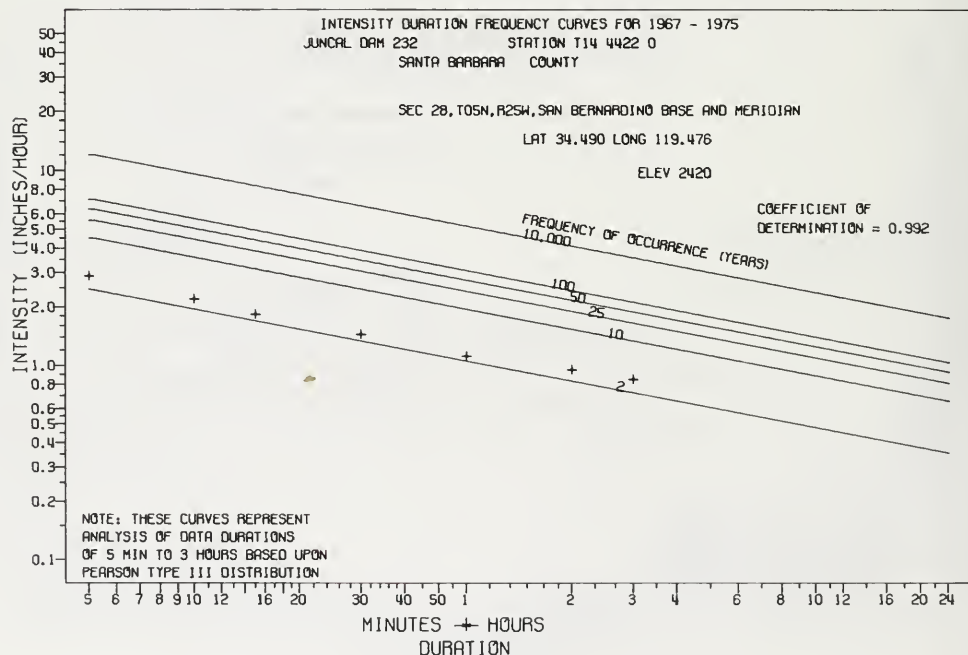
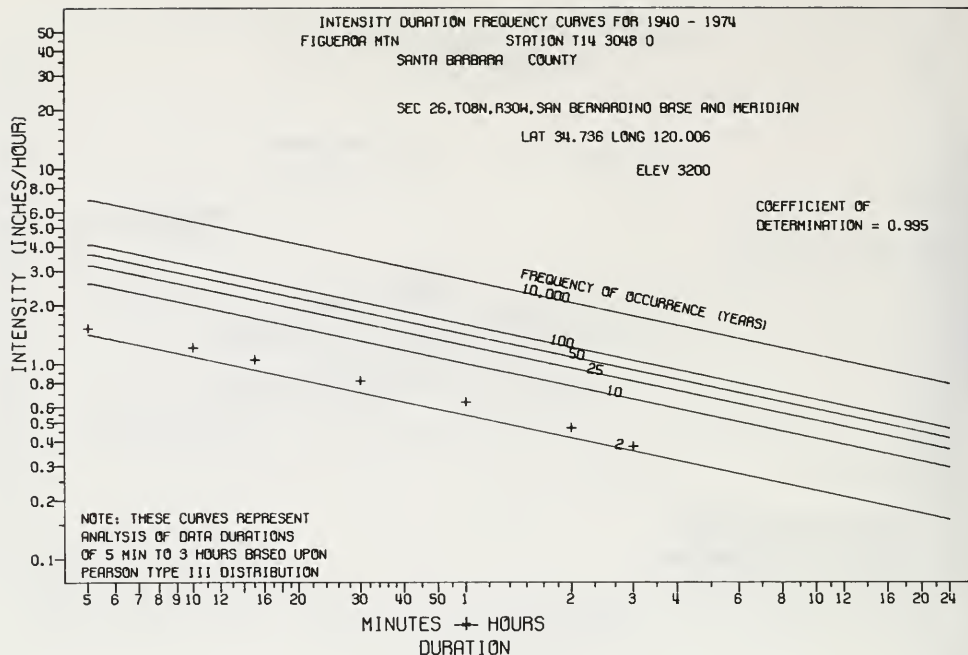




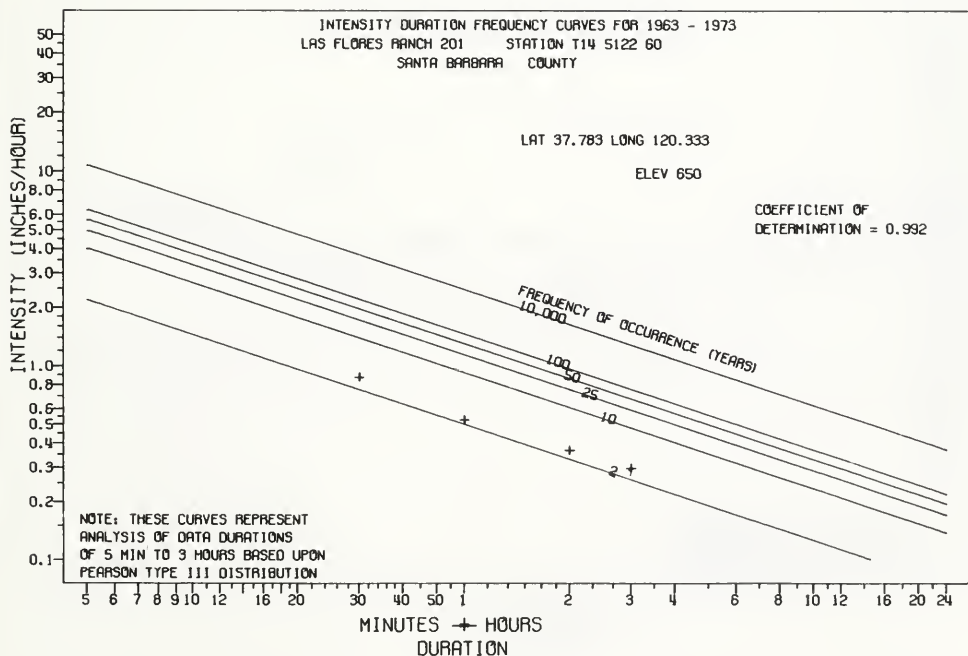
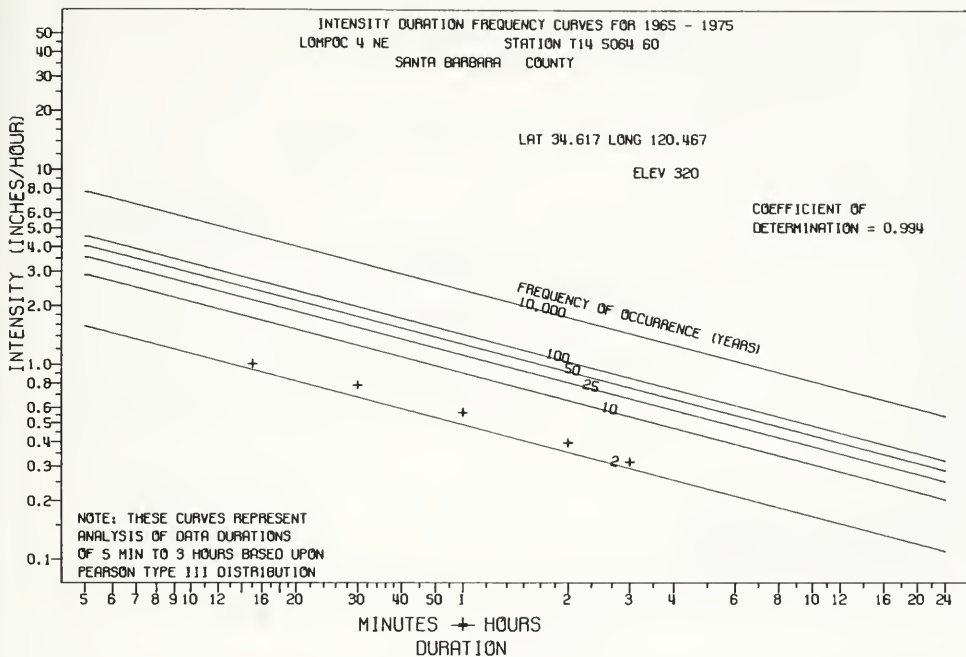


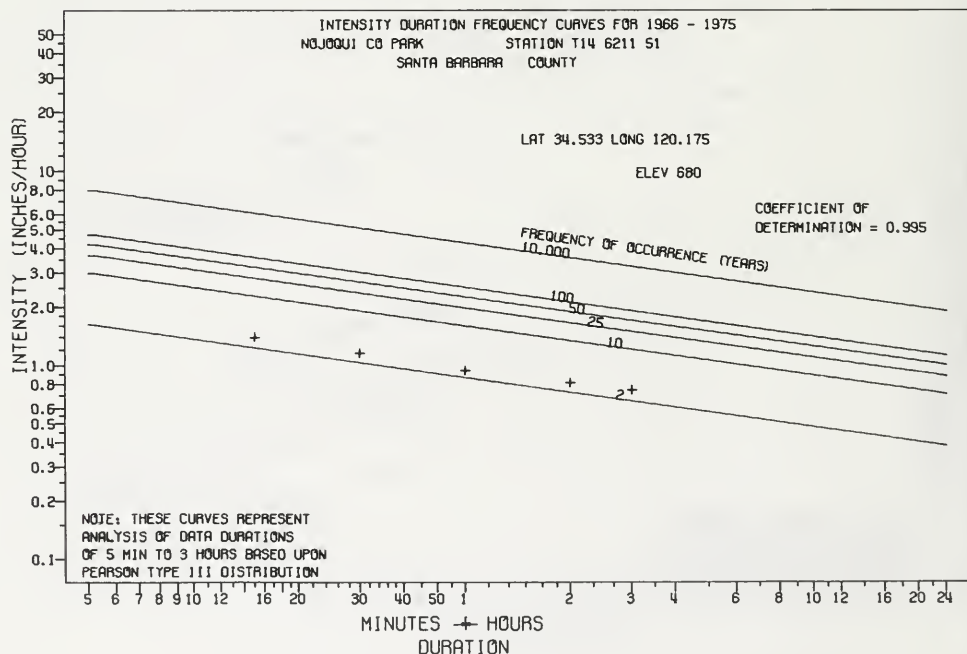
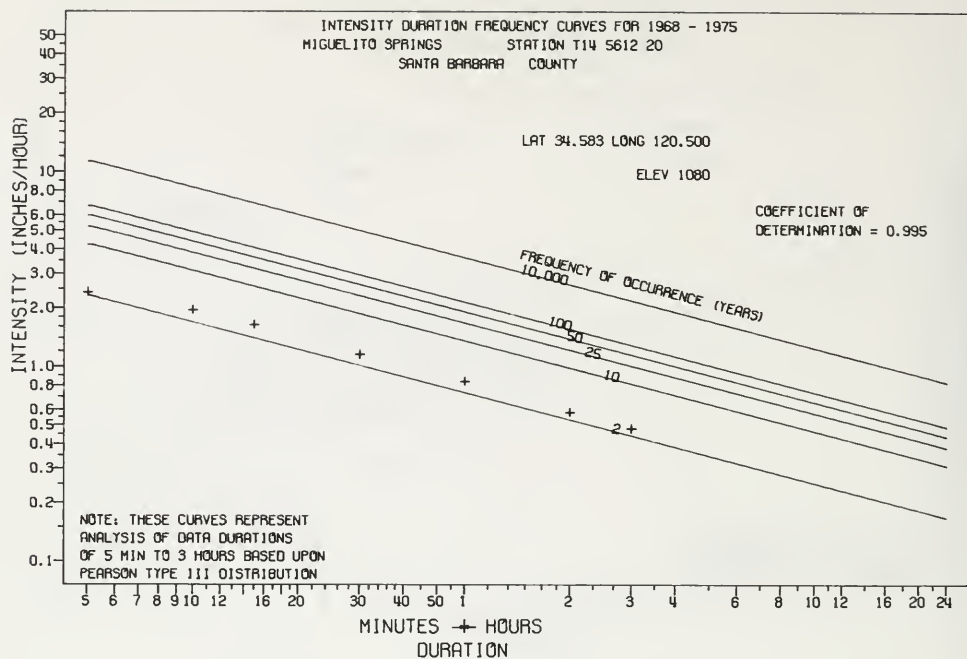


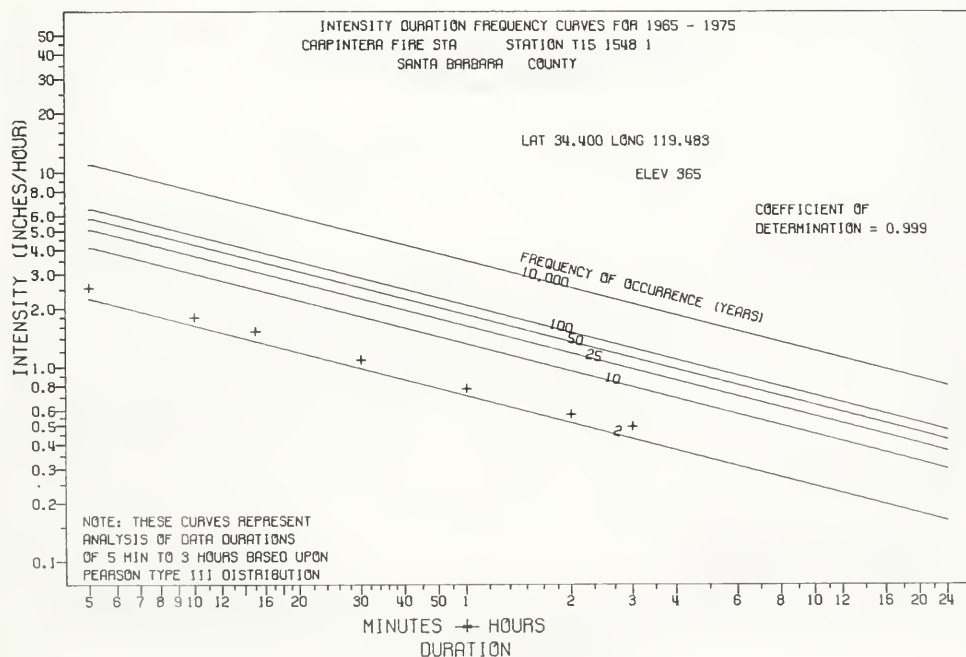
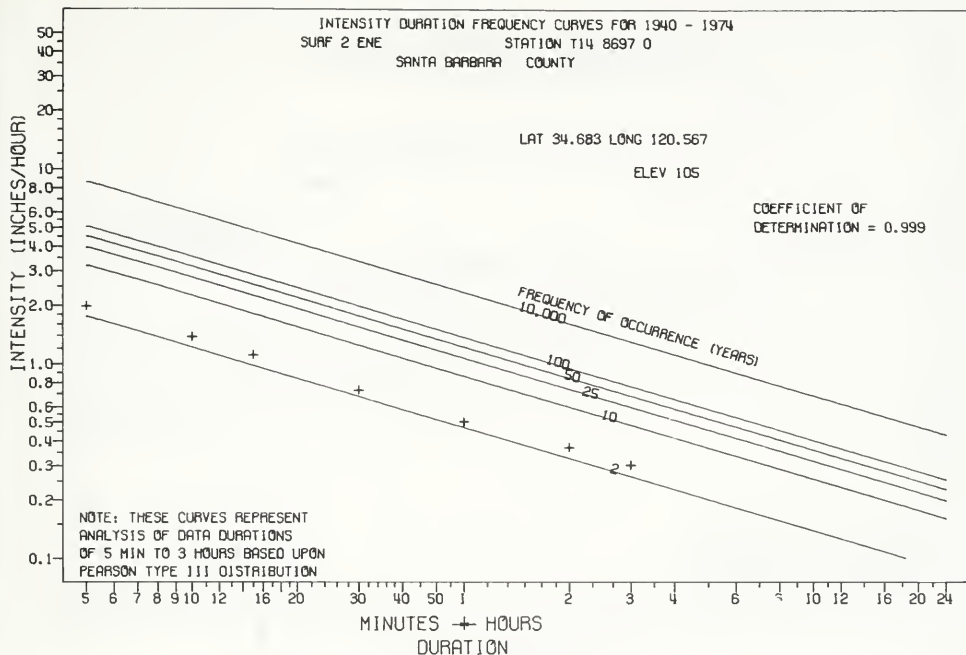


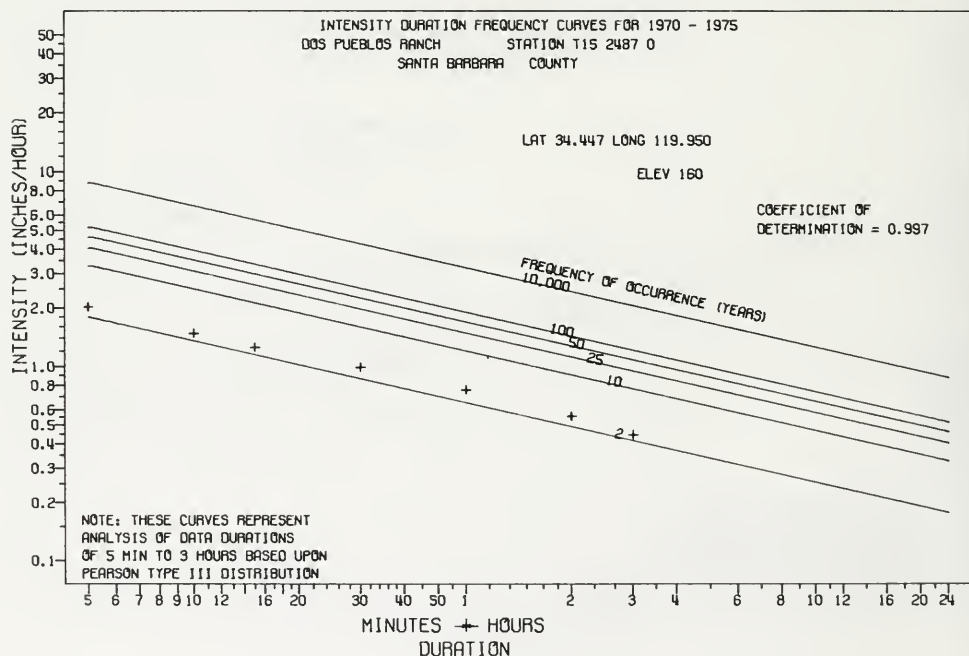
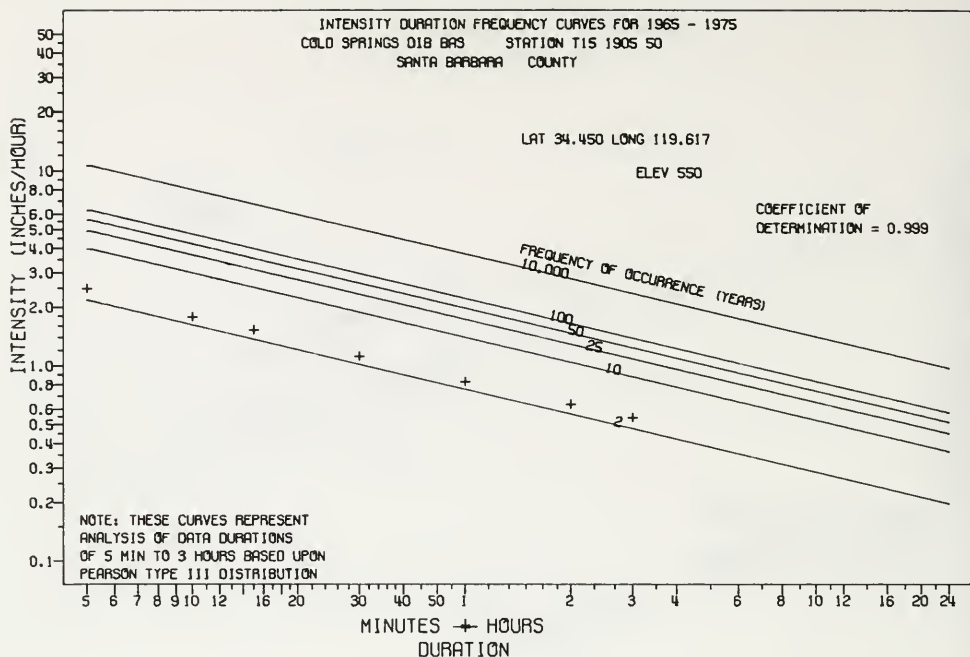


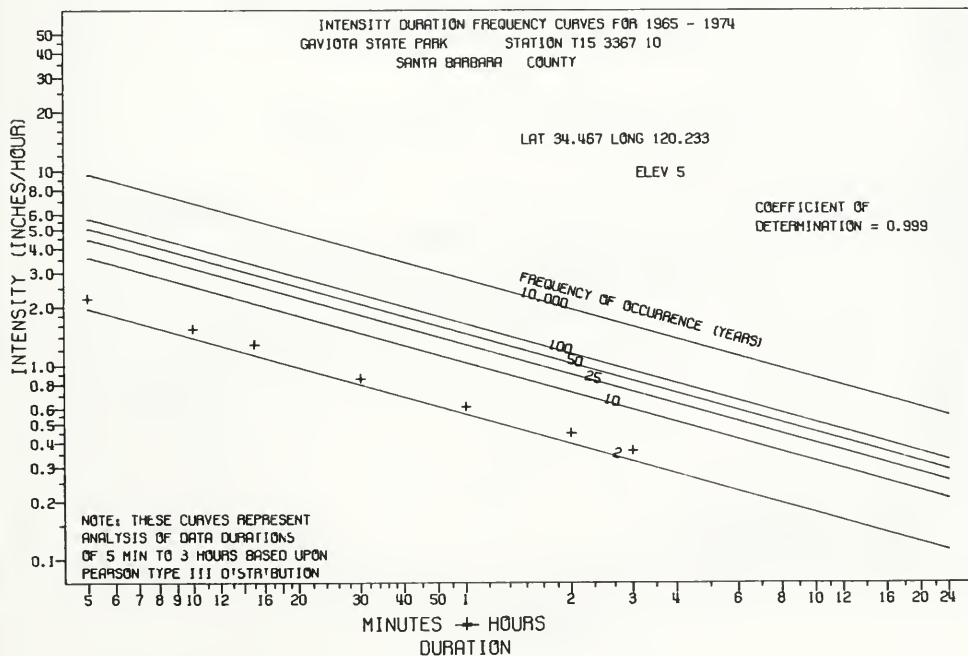
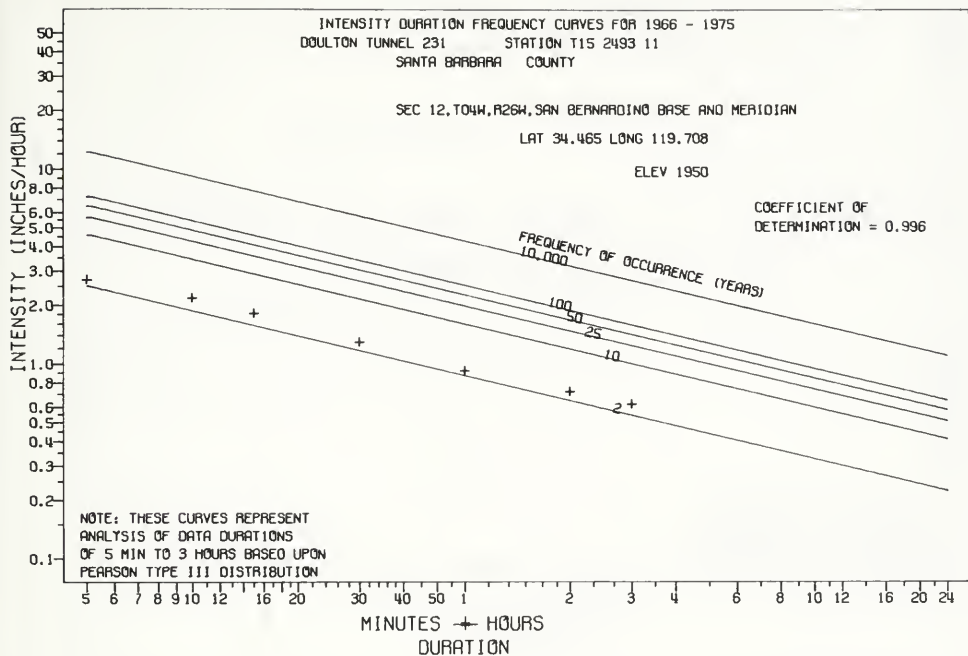


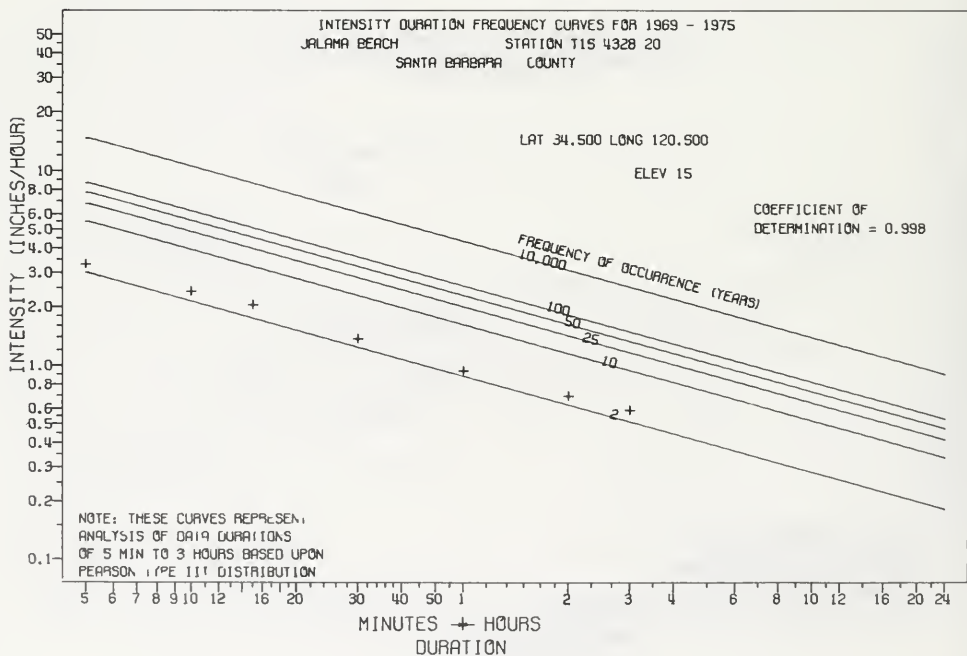
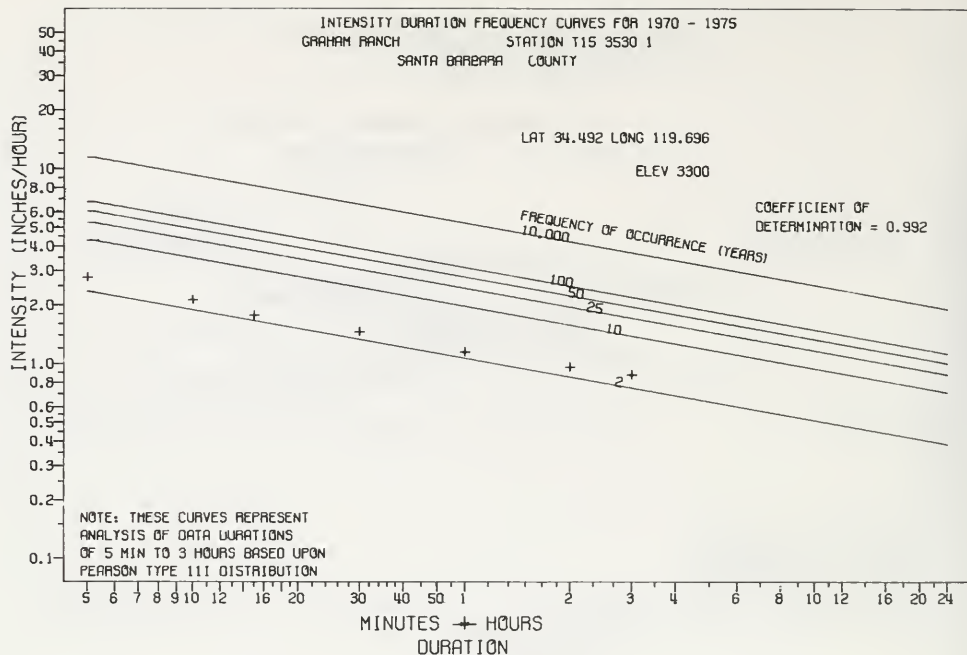


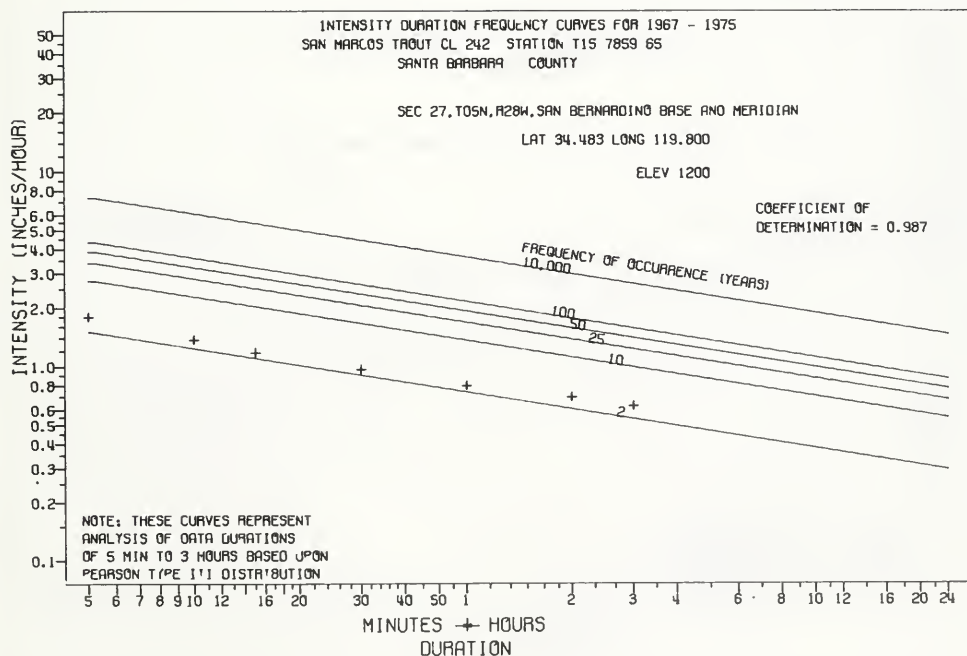
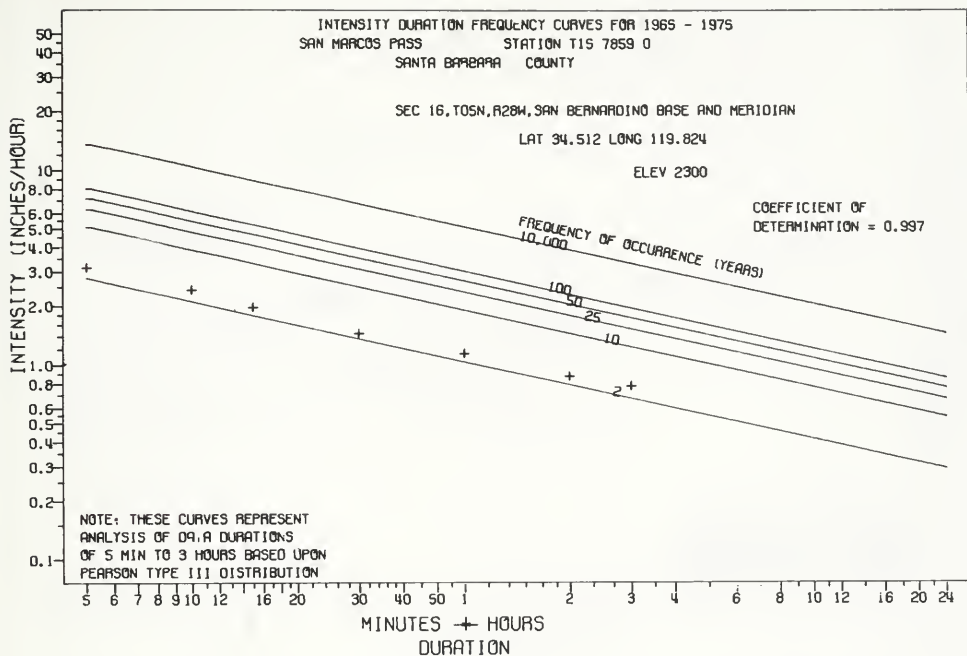




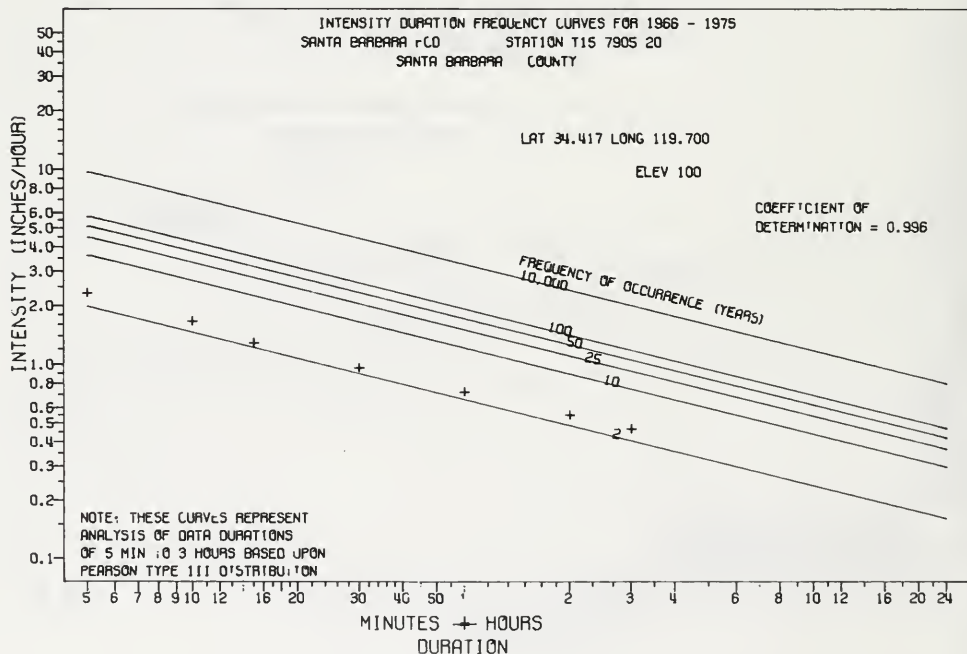
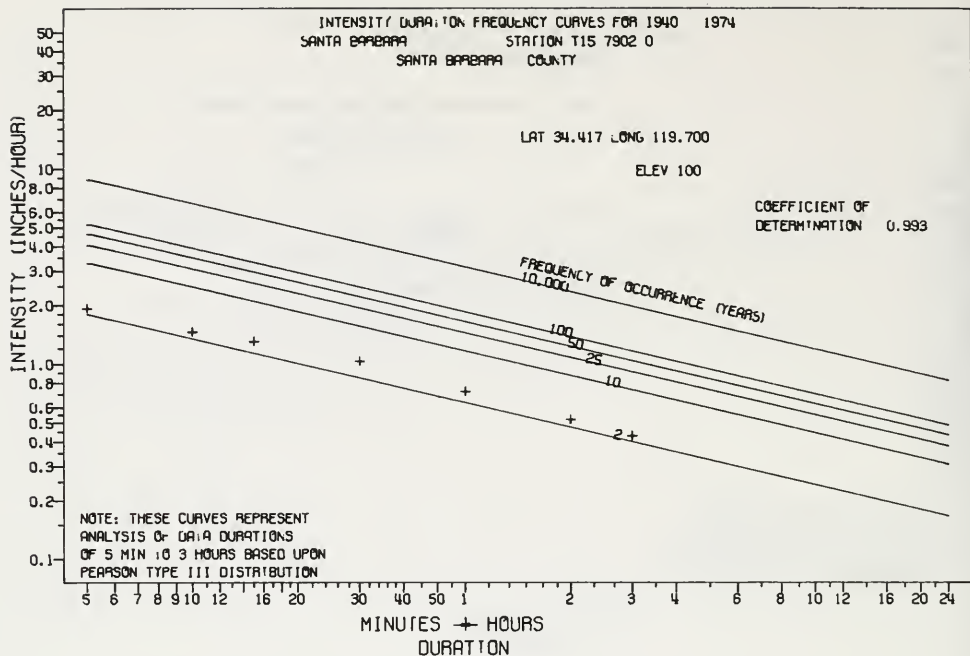






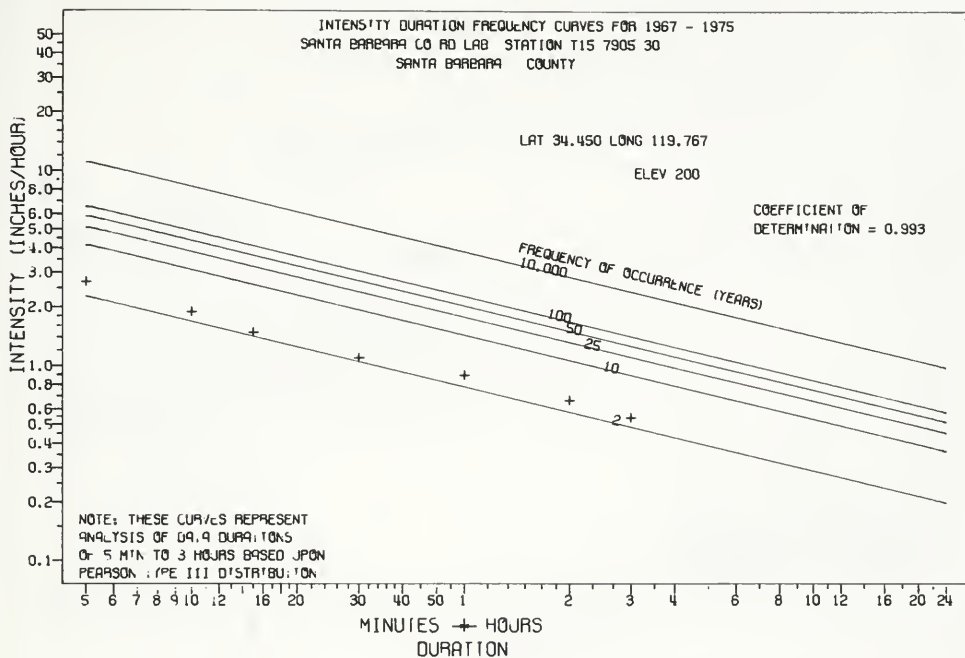




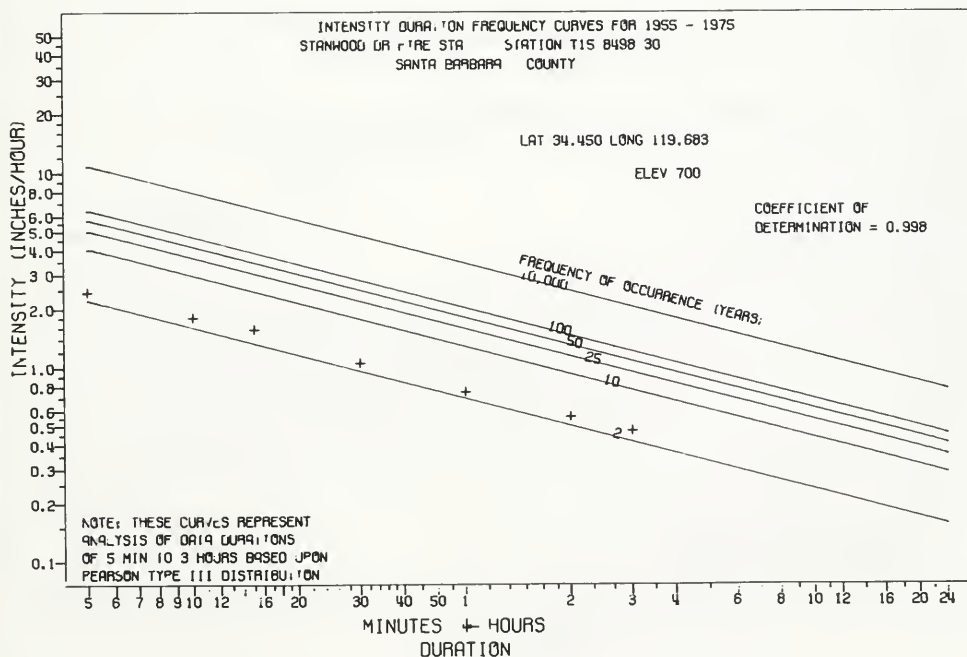


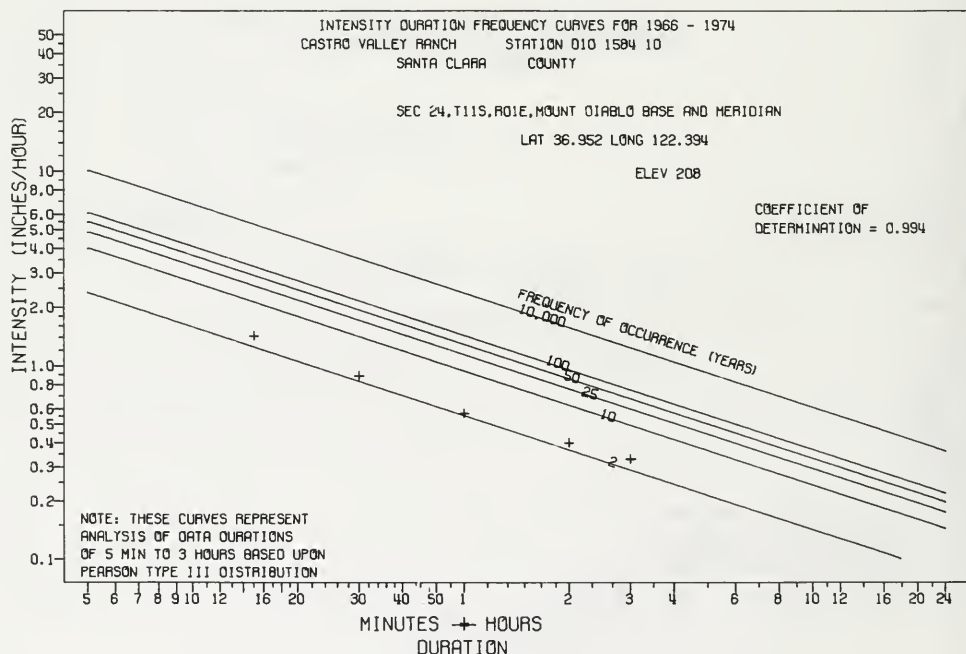
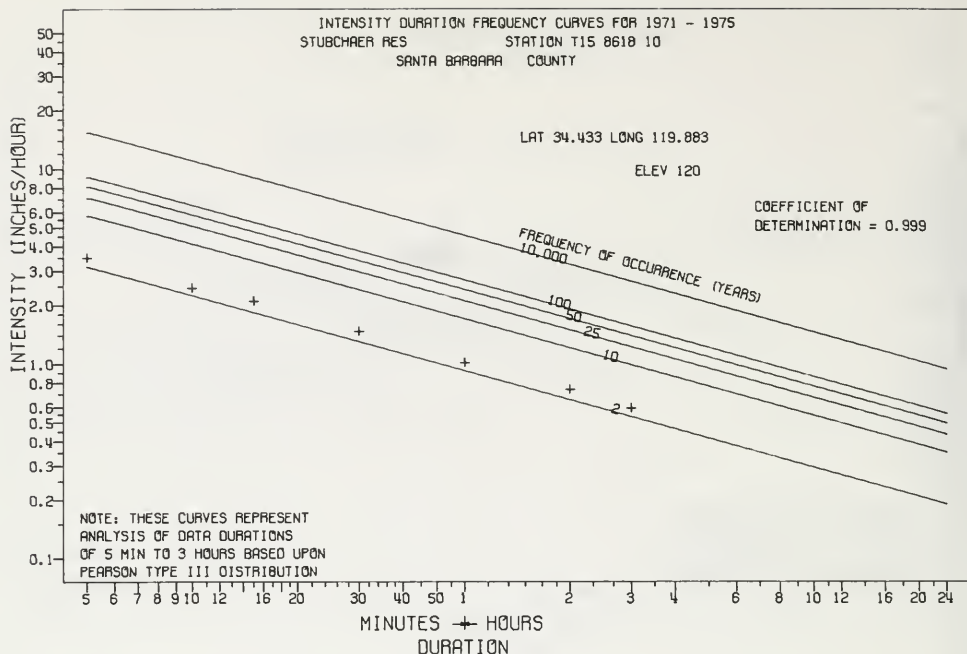


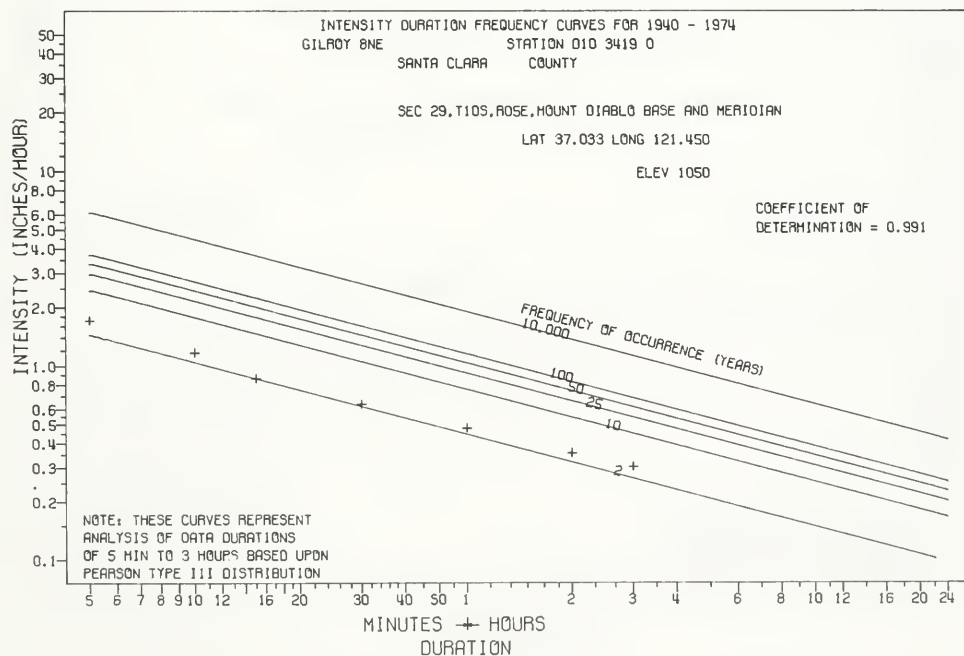
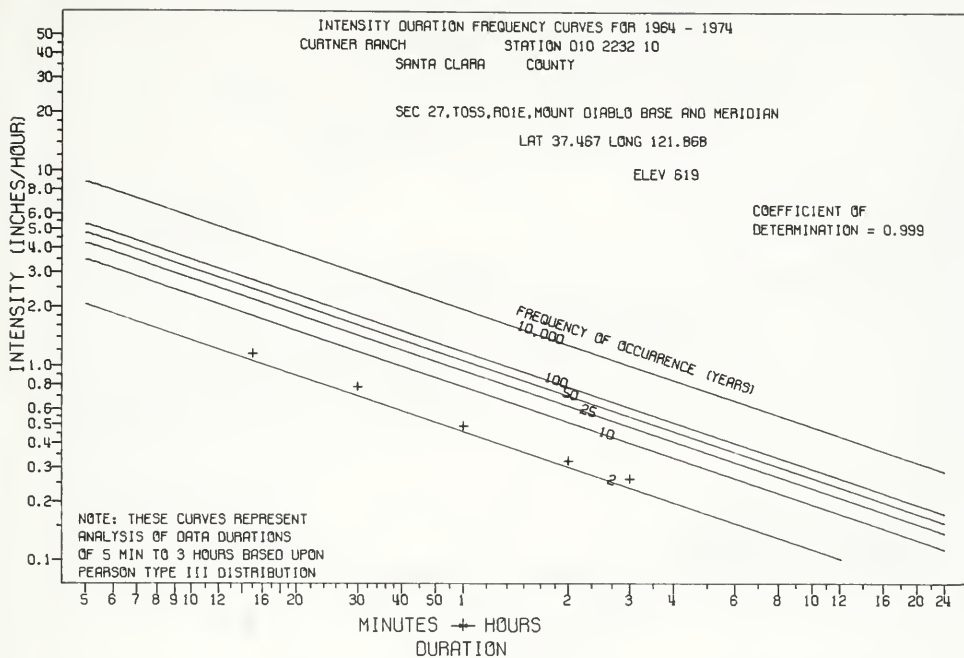
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SANTA BARBARA CO RD LAB STATION T15 7905 30  
SANTA BARBARA COUNTY

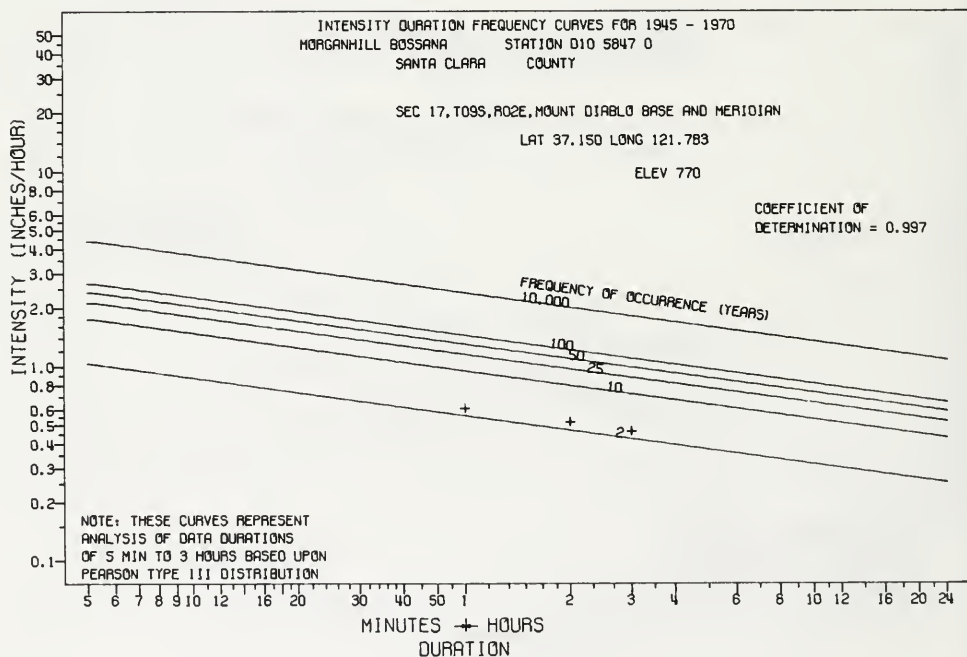
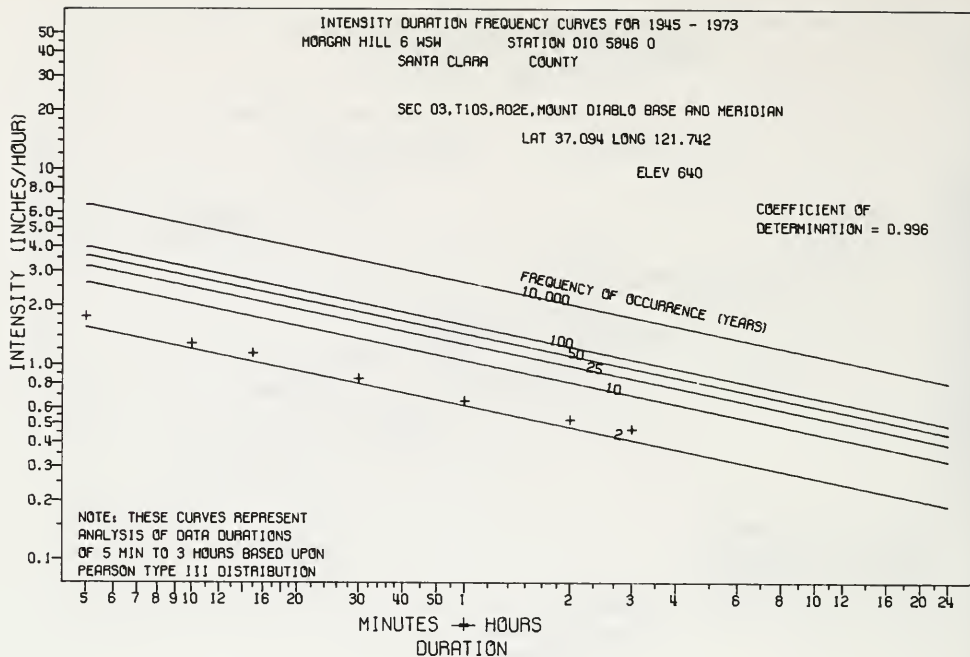


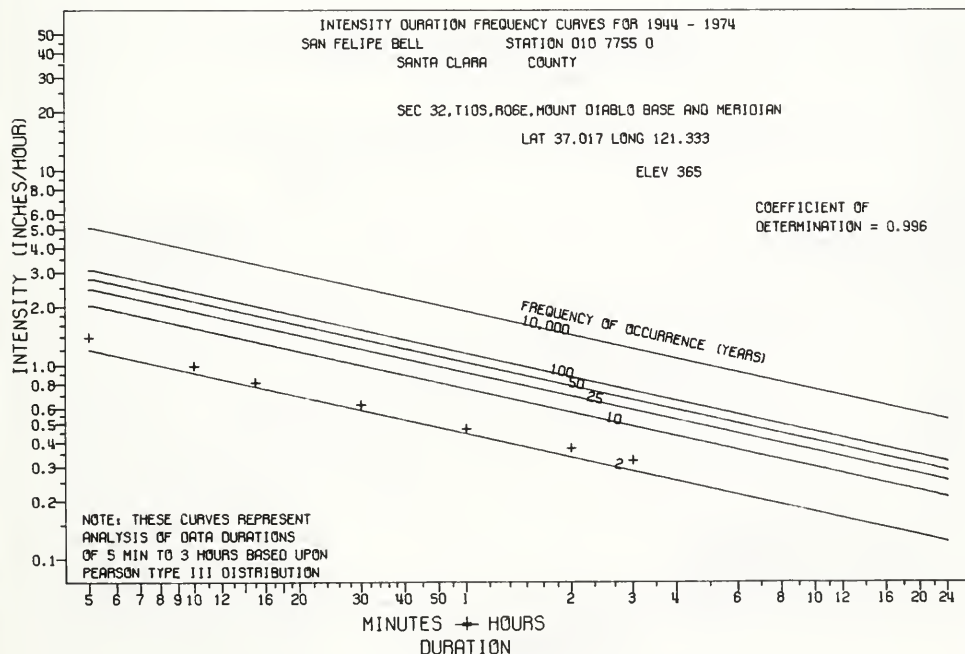
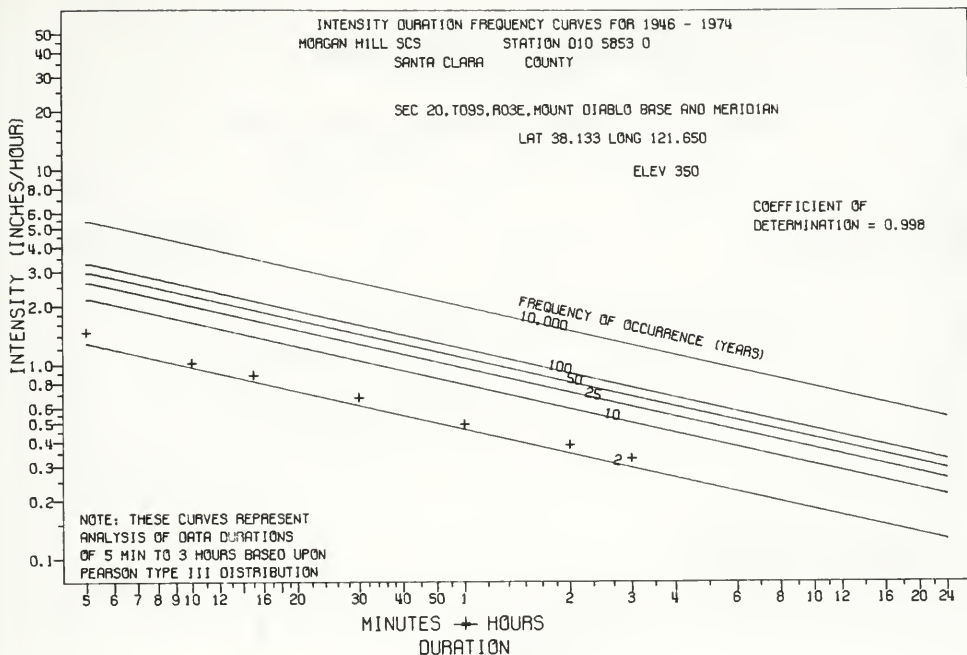
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STANHOOD OIL PIPE STATION T15 8498 30  
SANTA BARBARA COUNTY

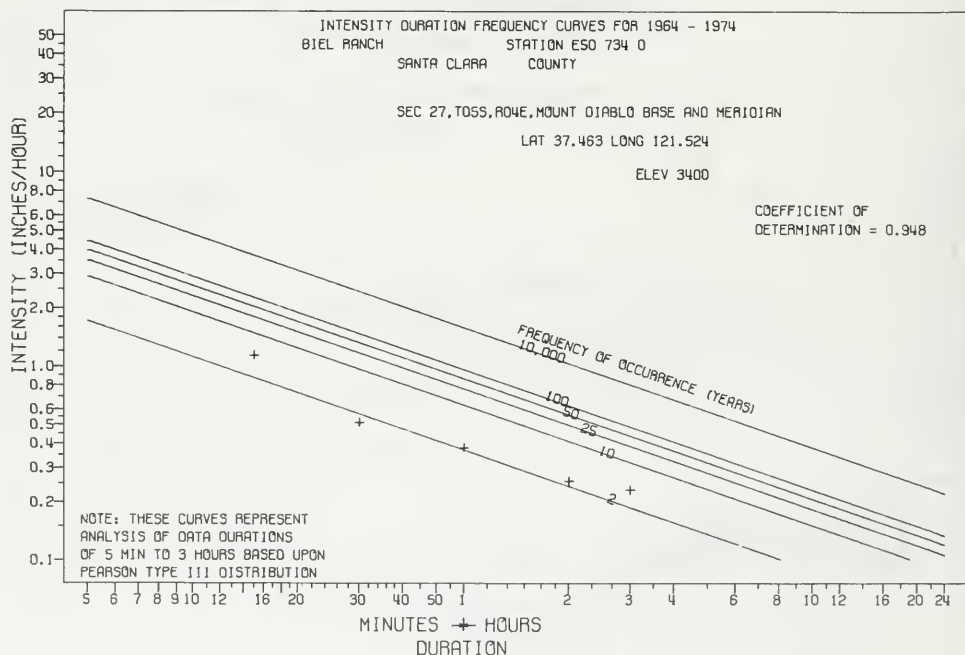
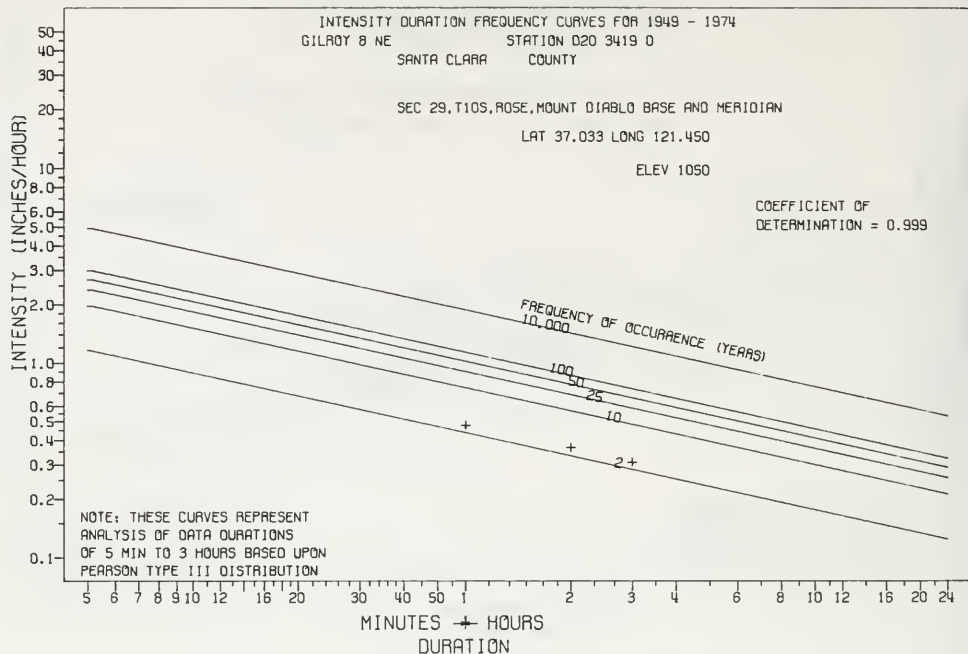


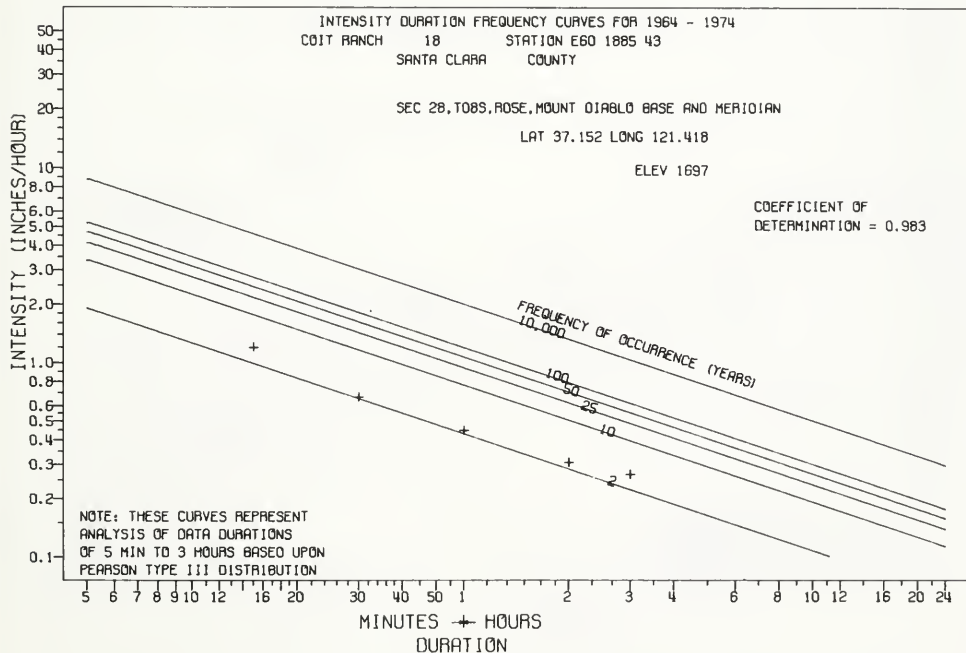
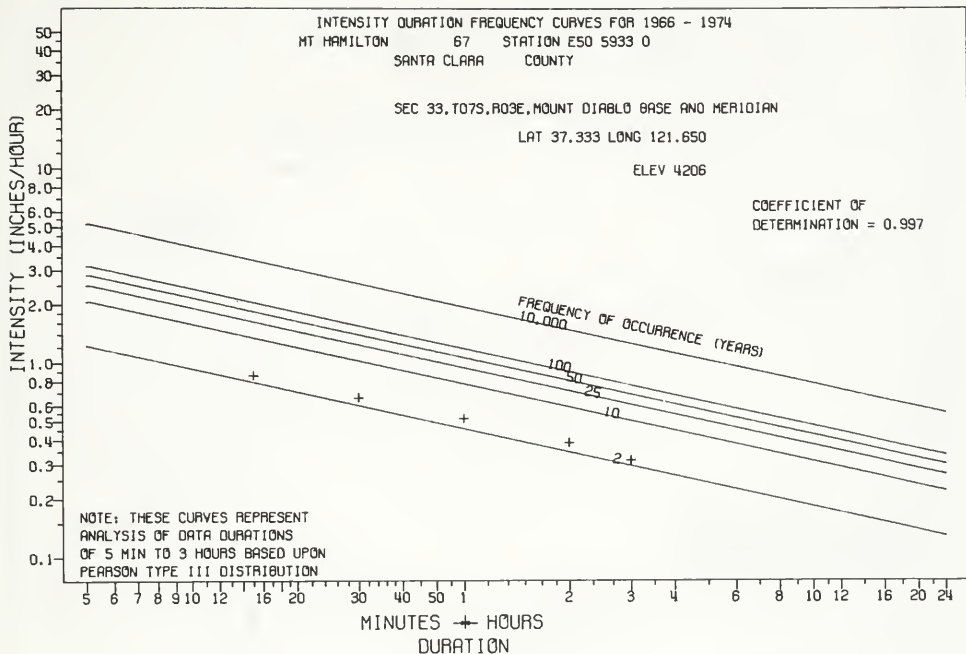




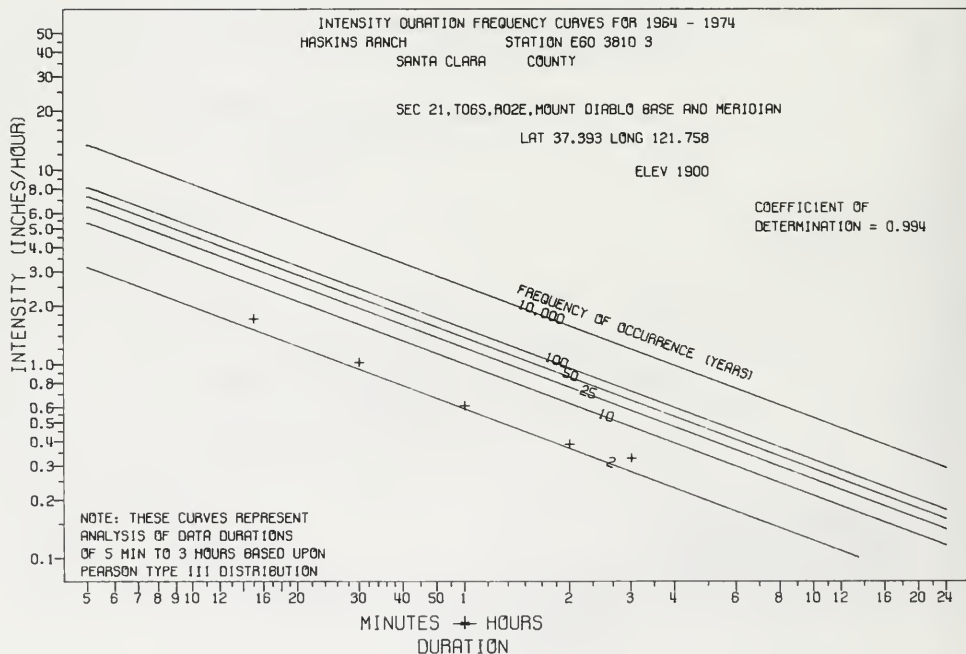
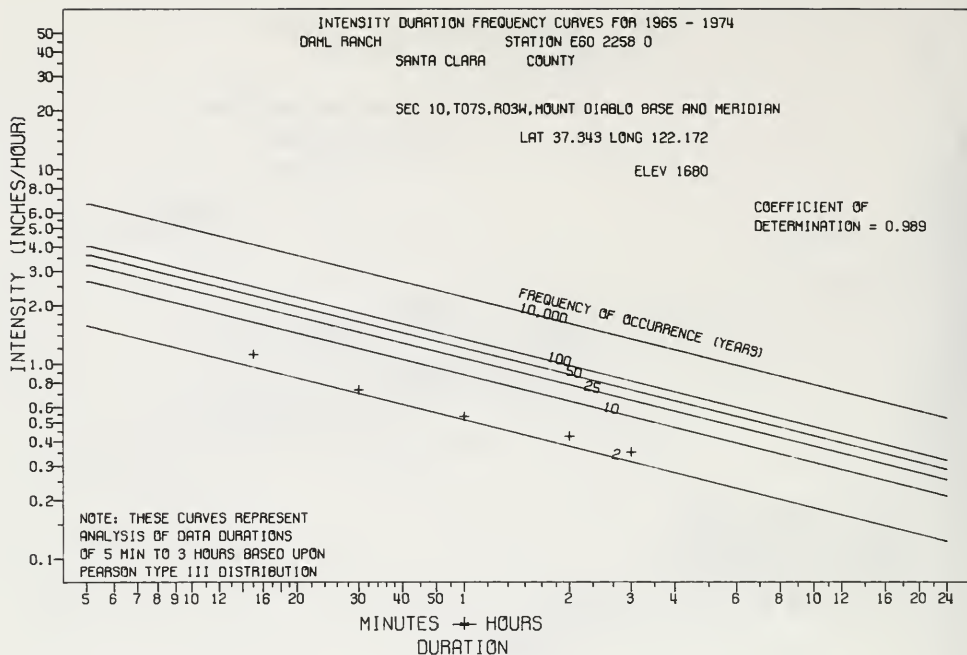




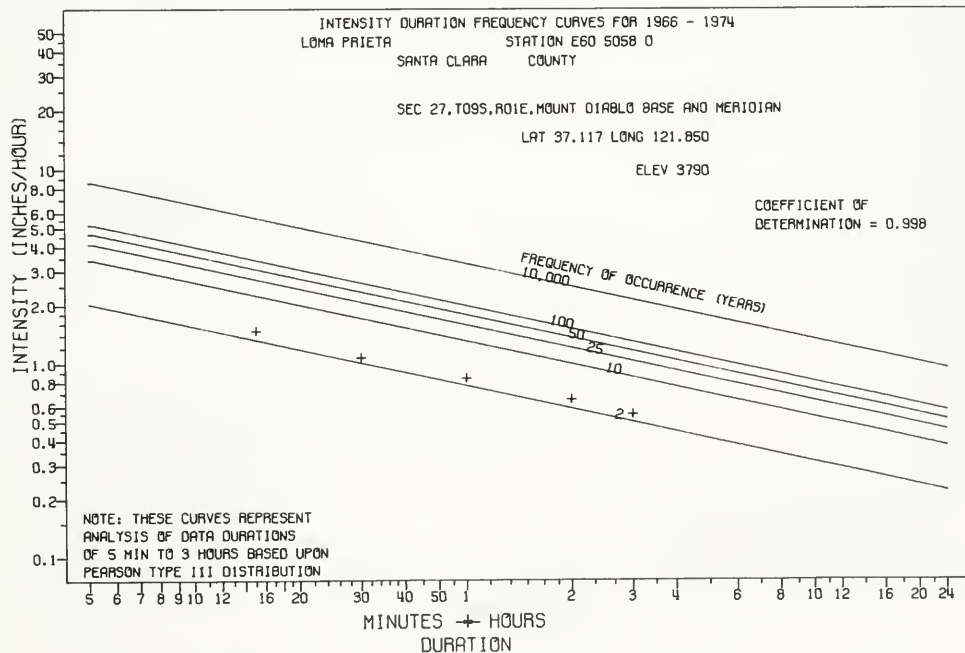
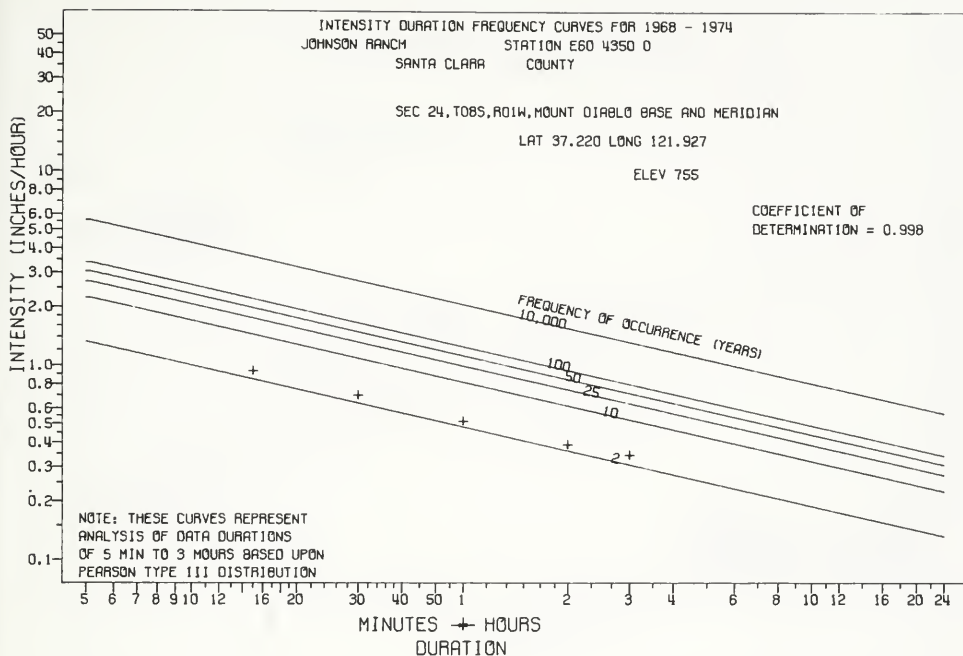


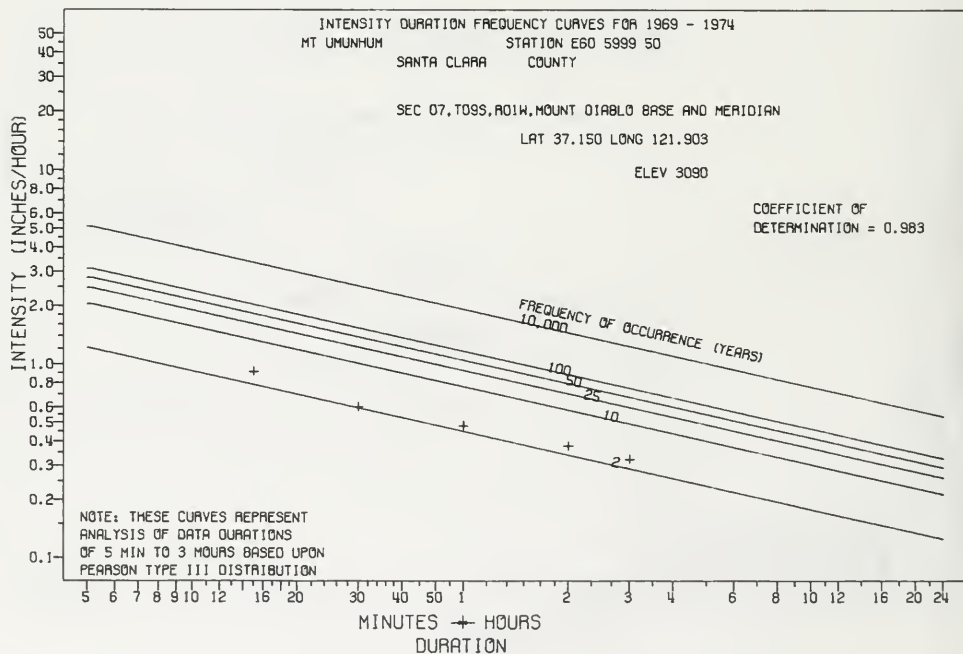
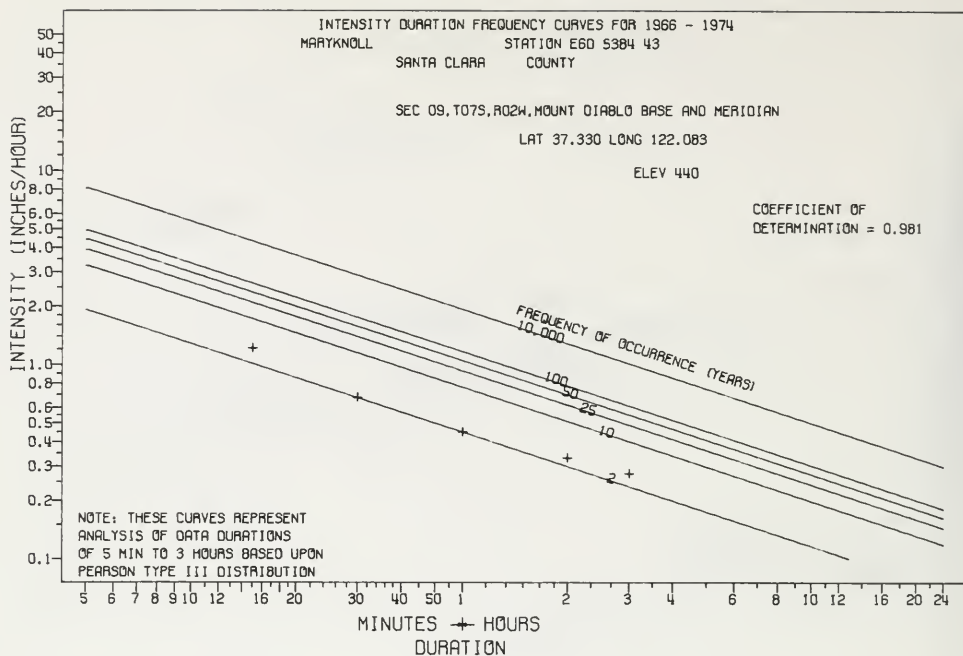


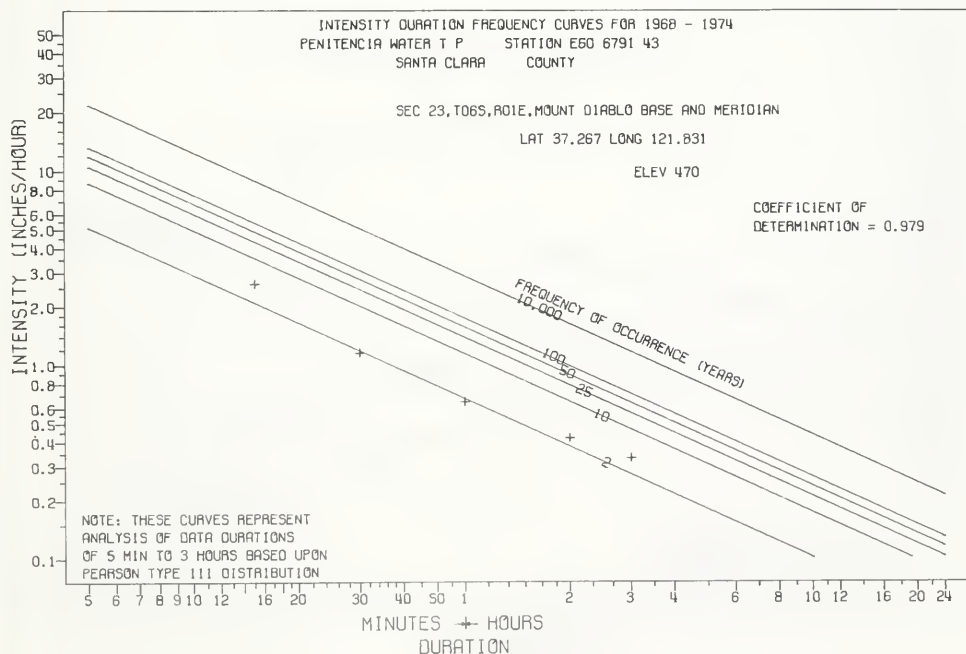
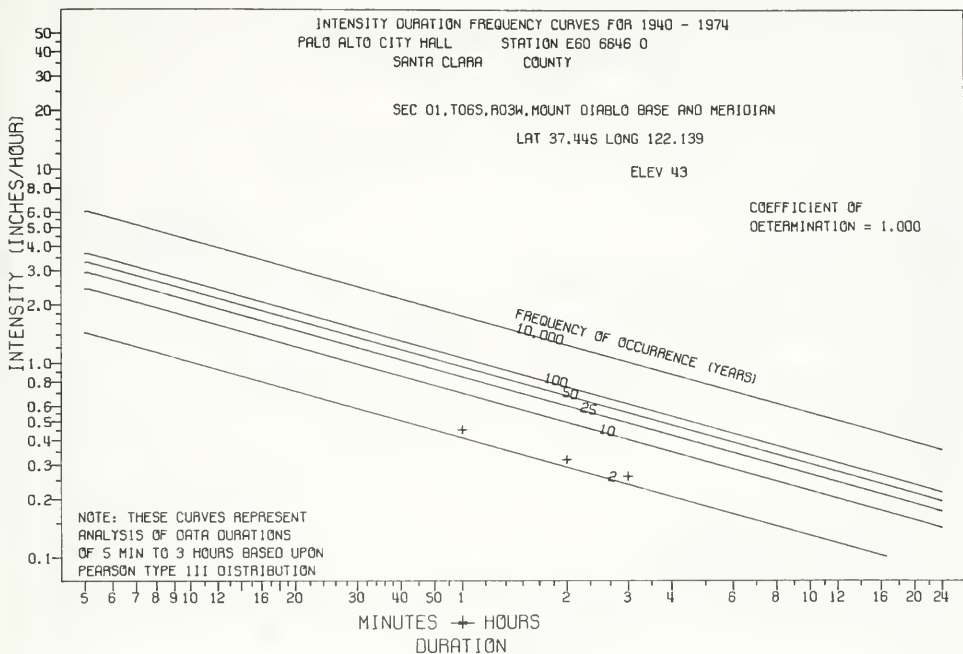


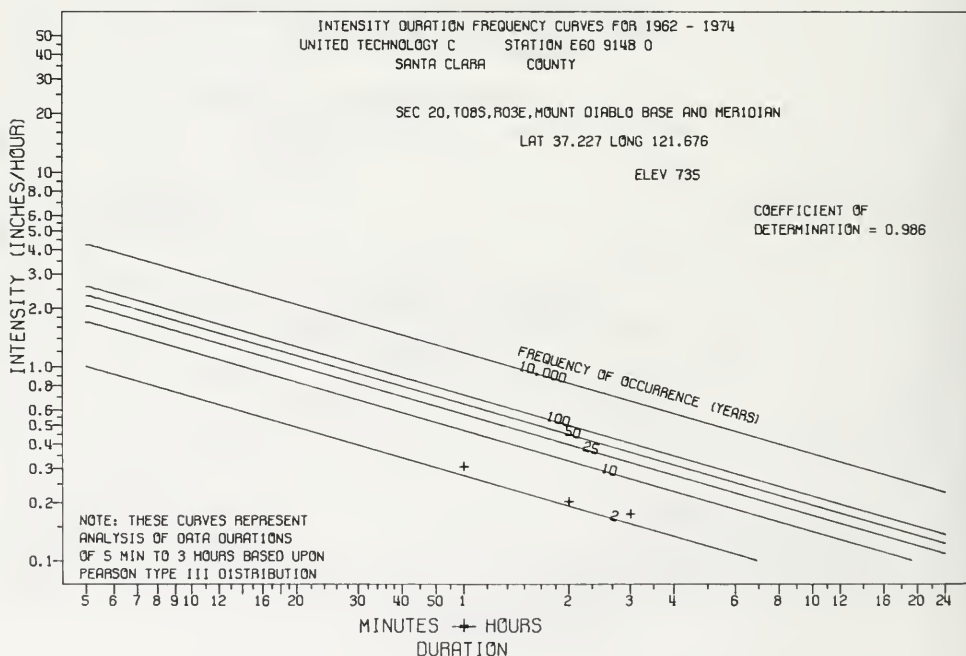
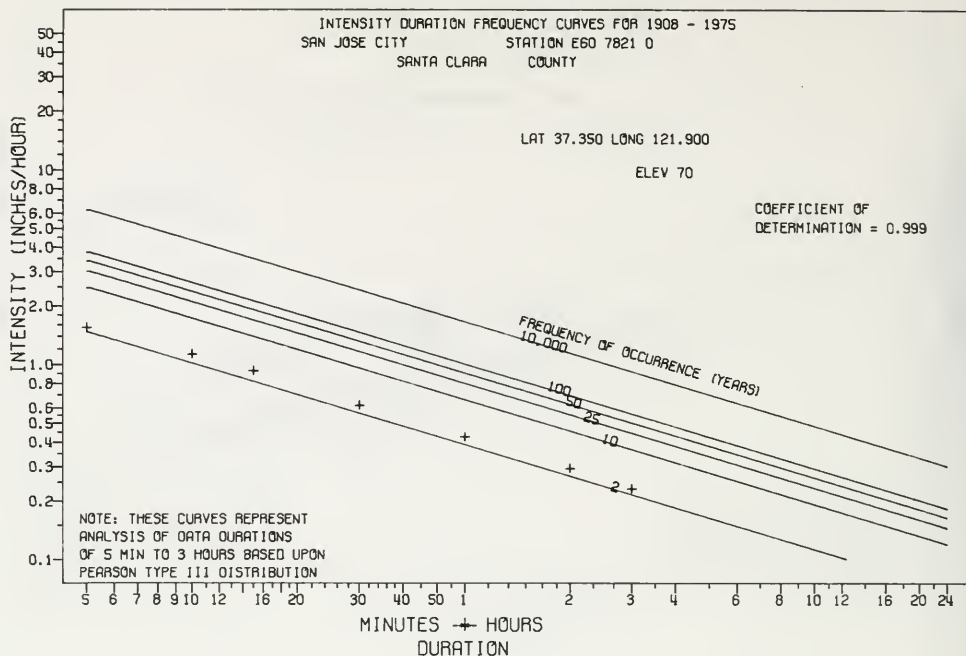


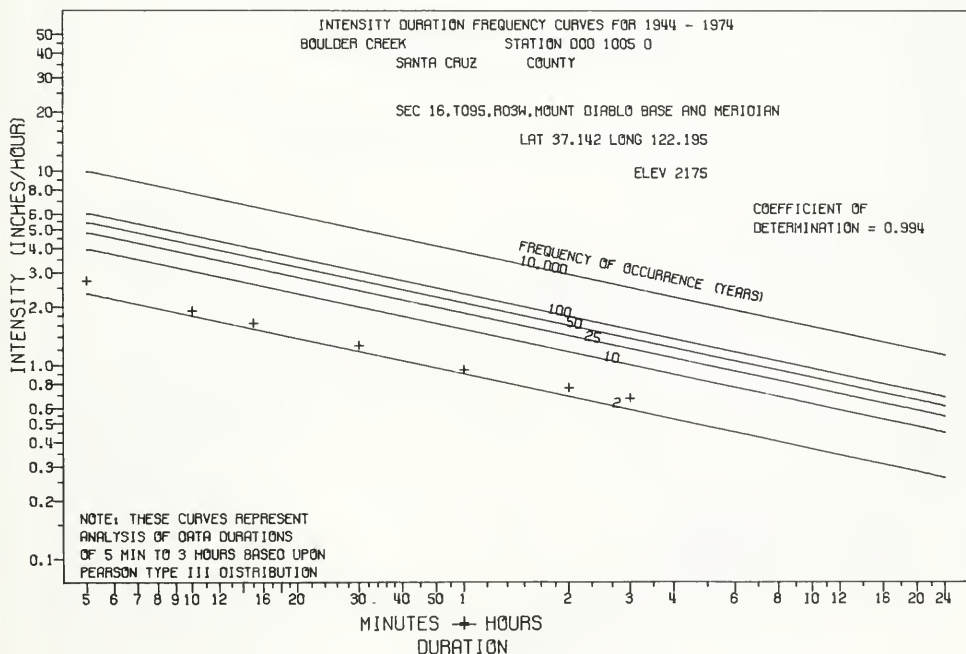
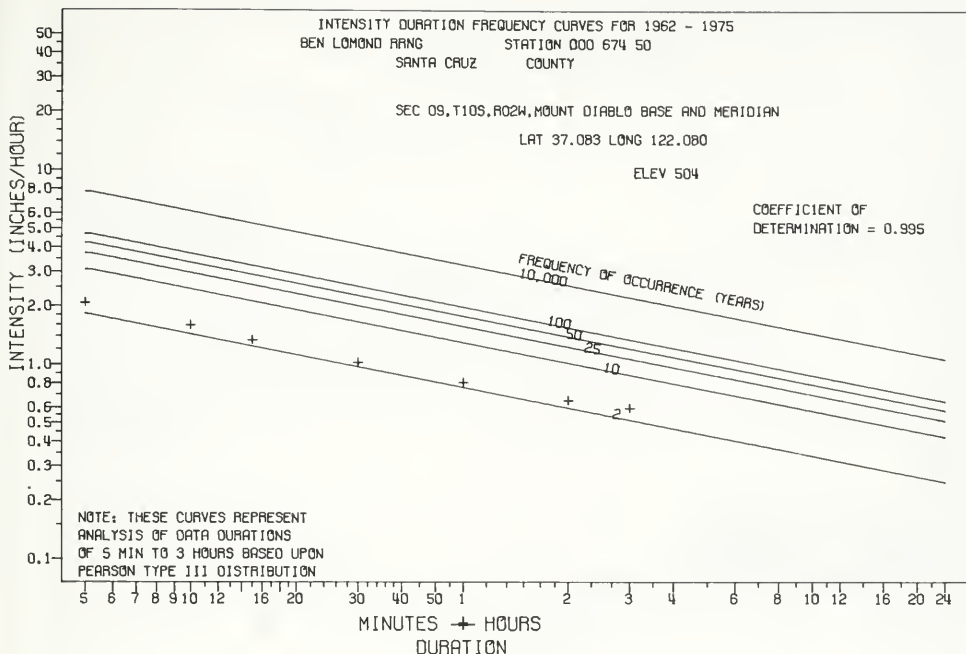


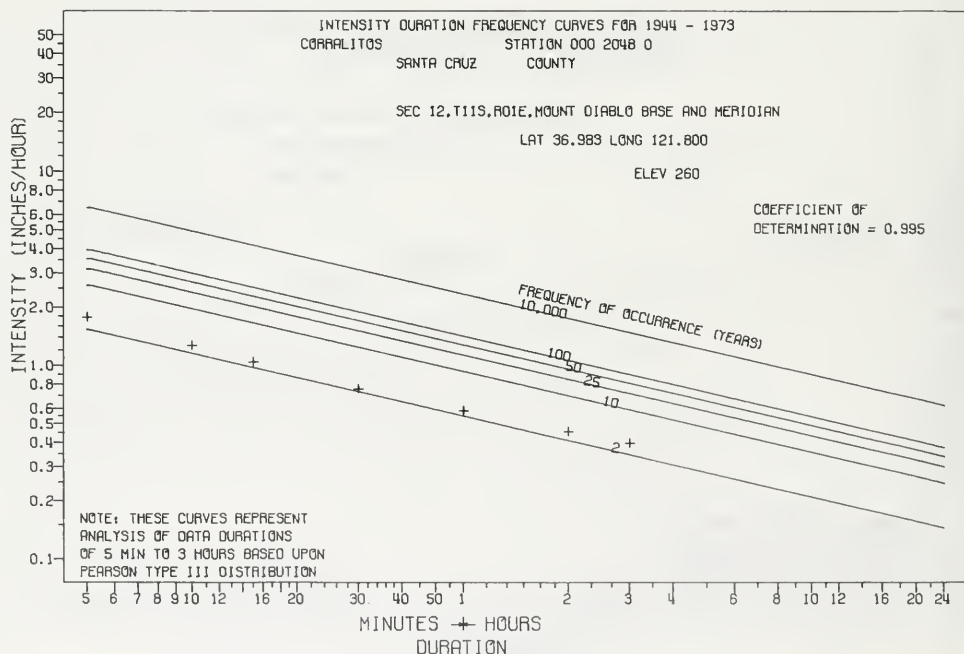
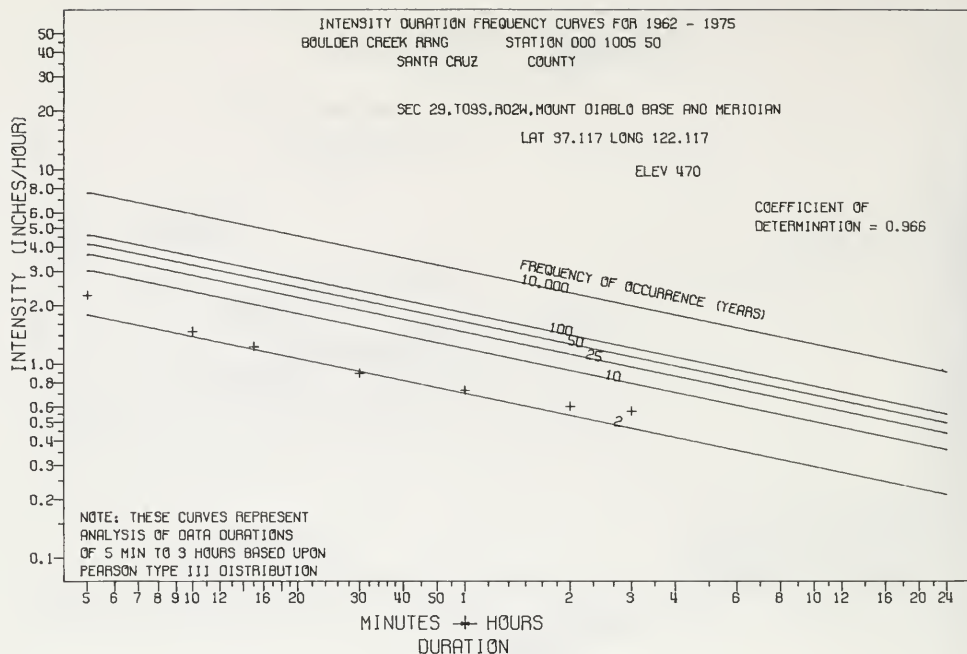


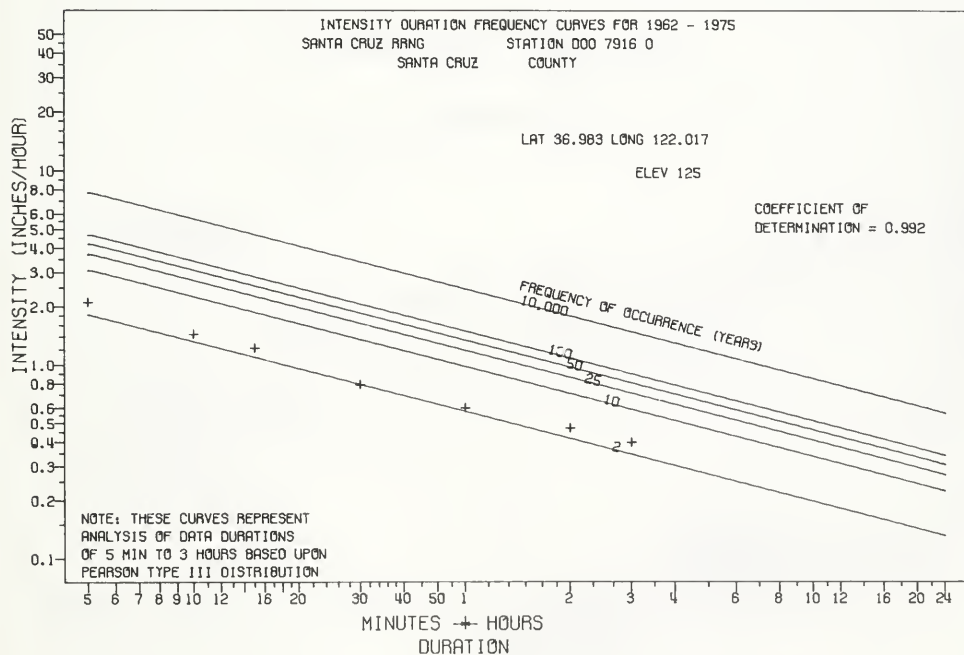
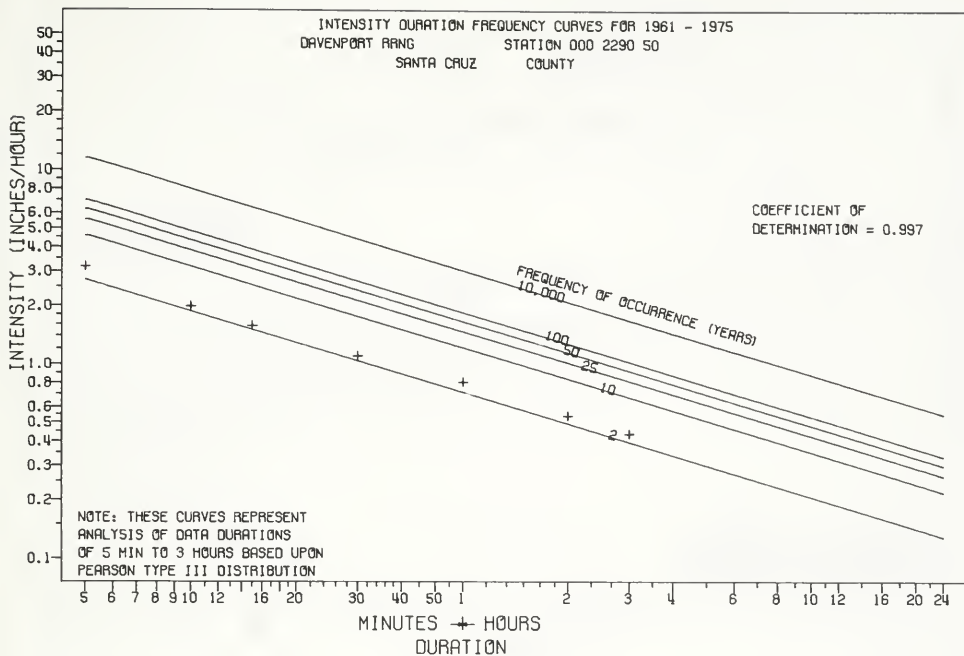


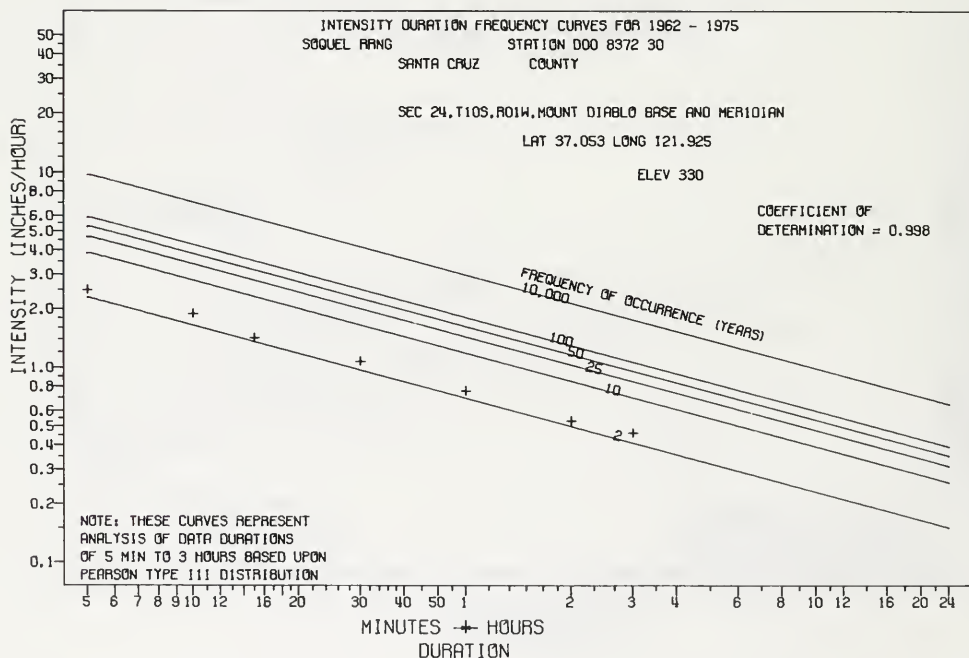
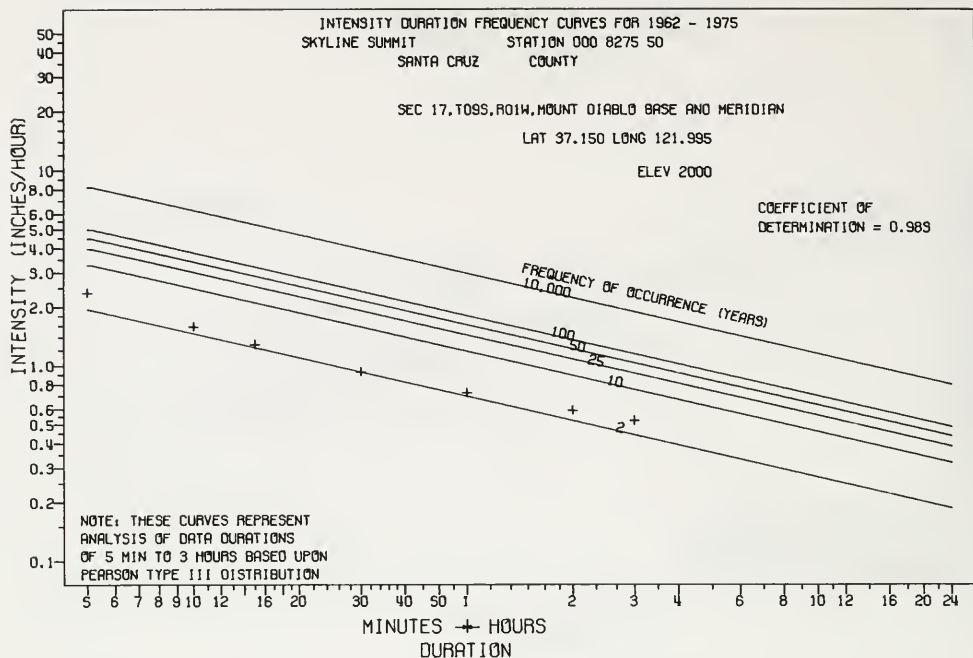




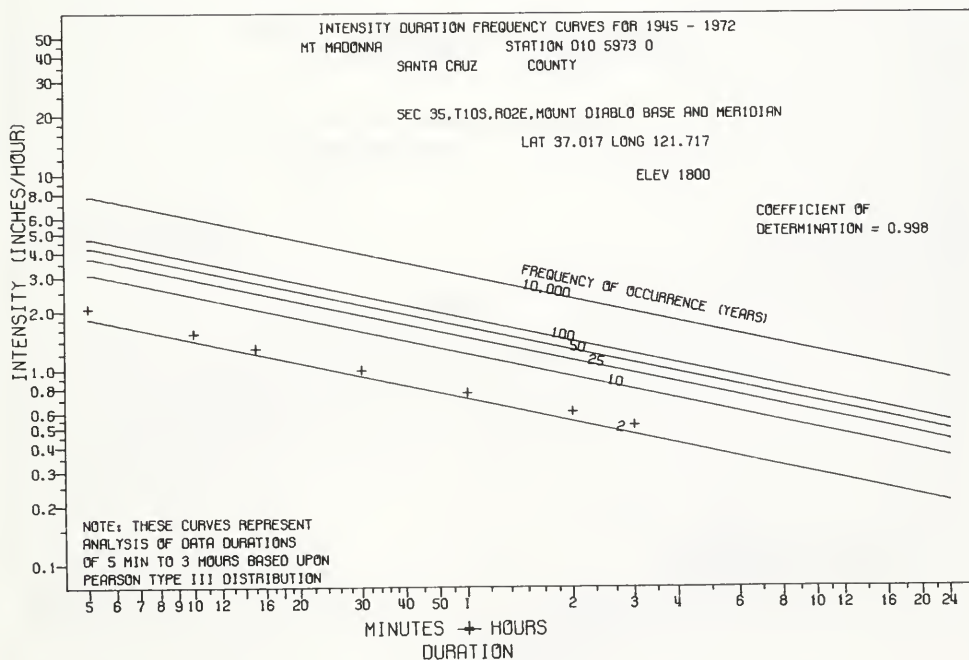
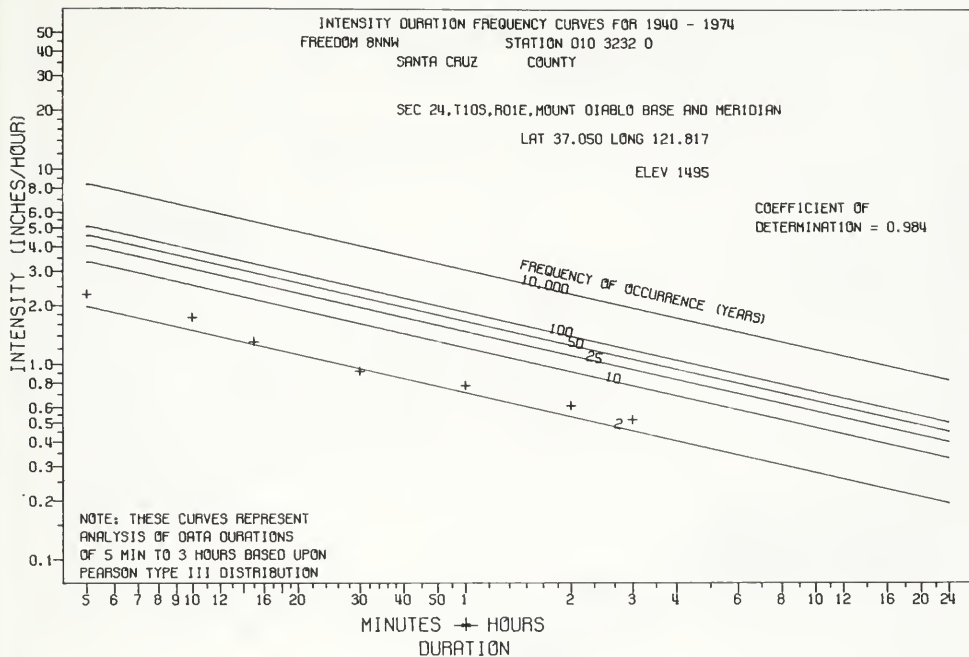


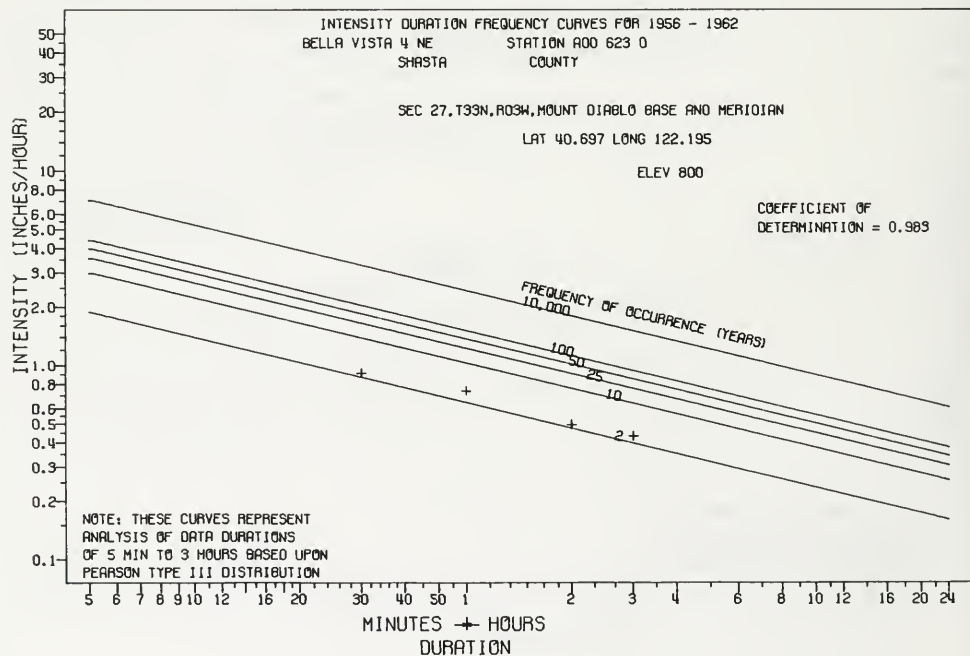
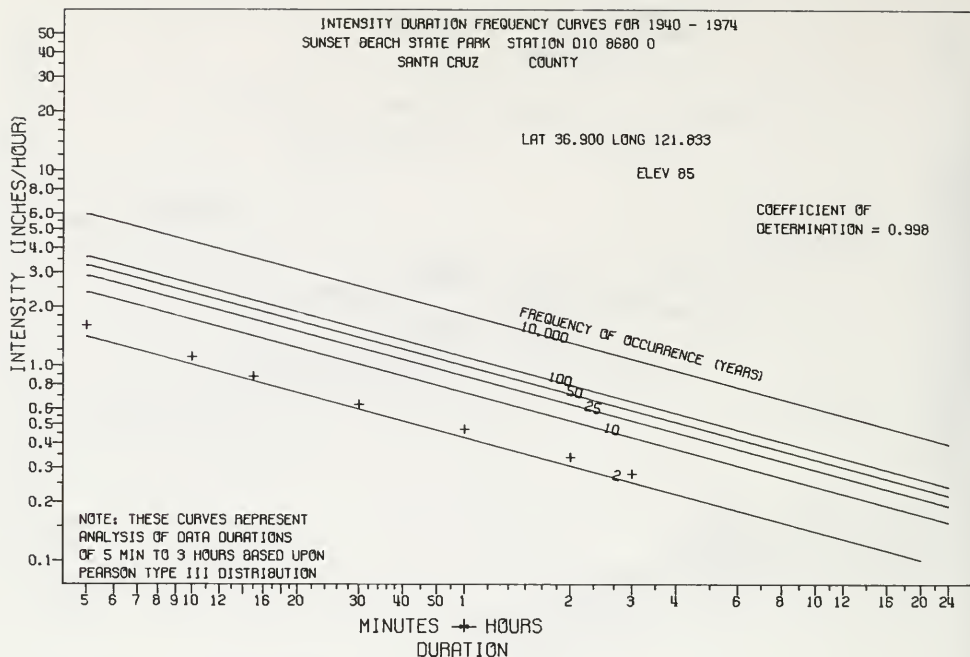


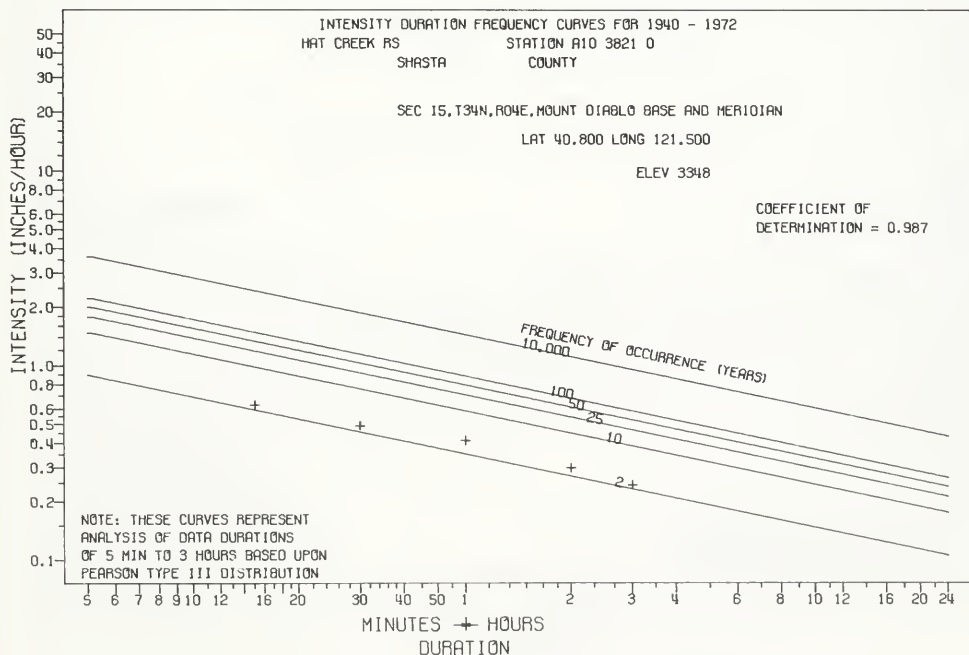
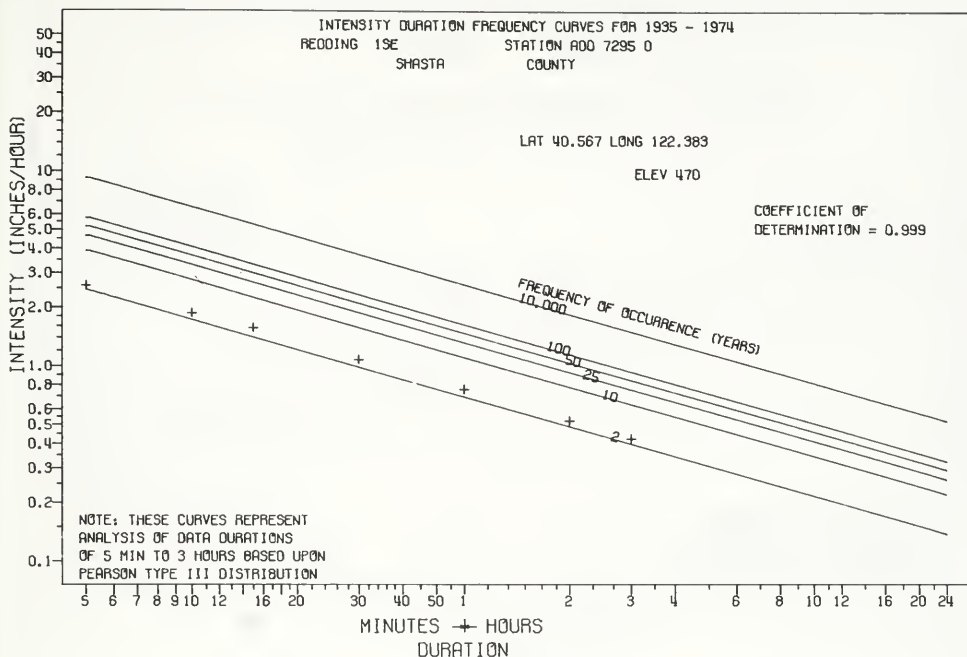


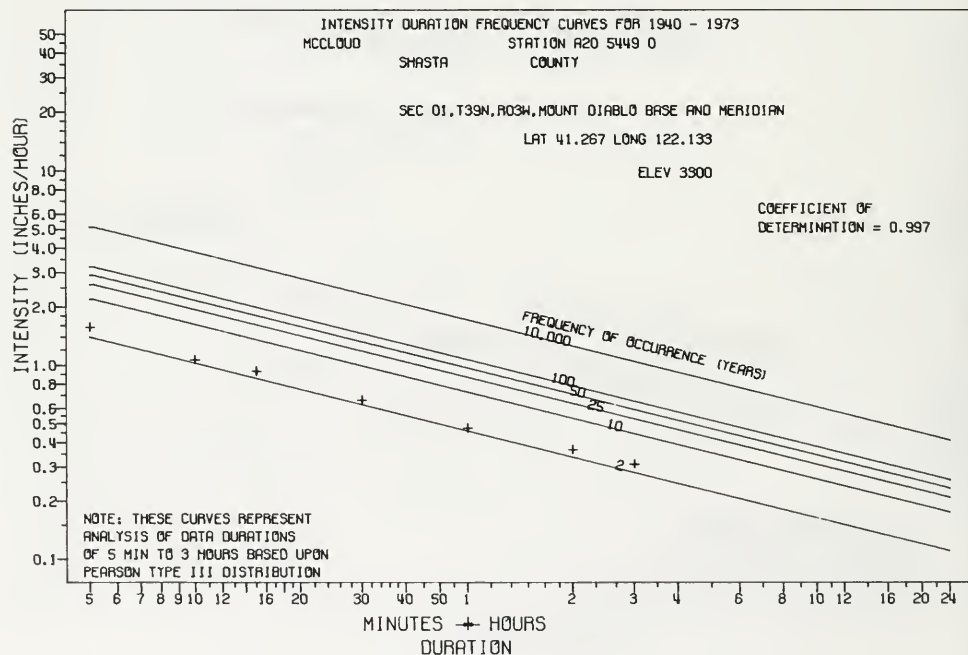
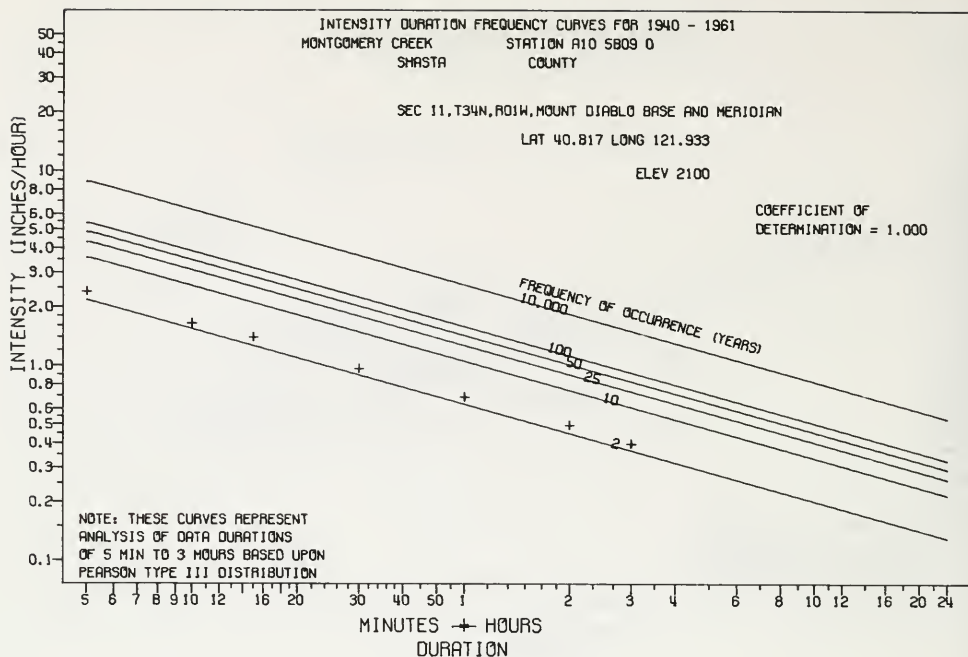


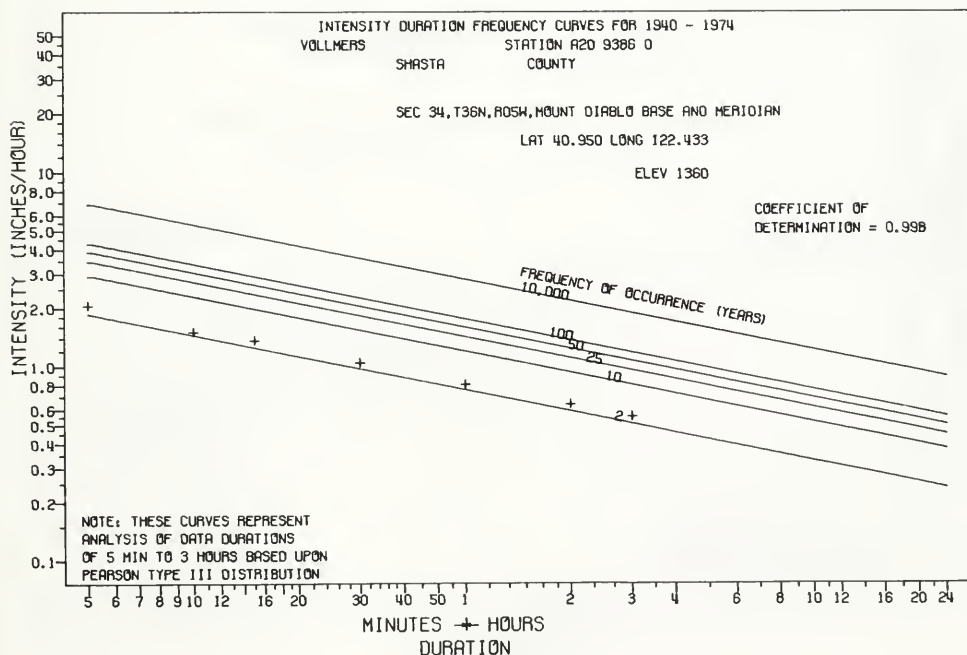
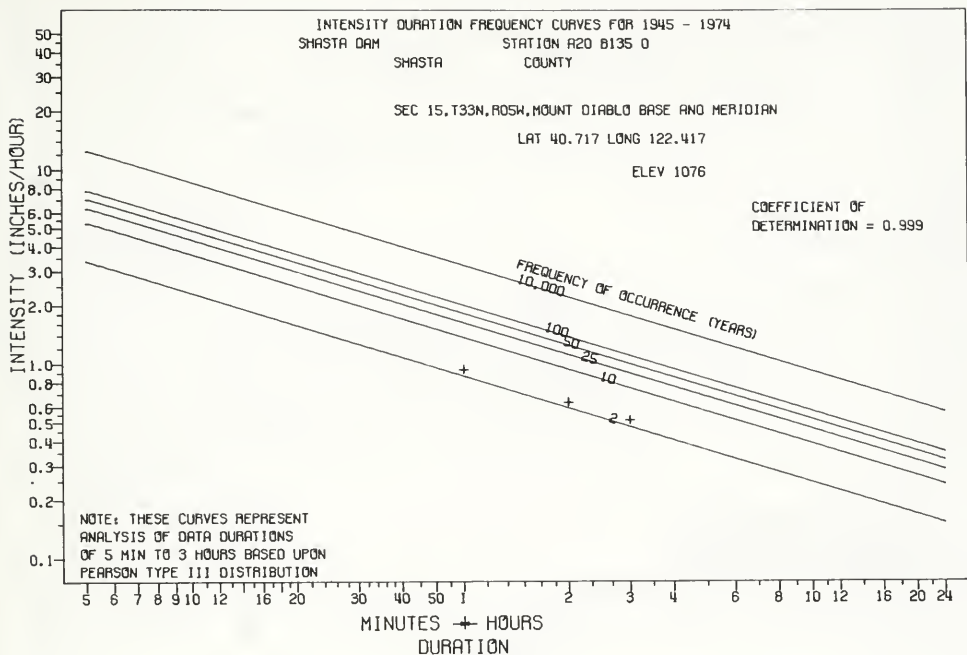


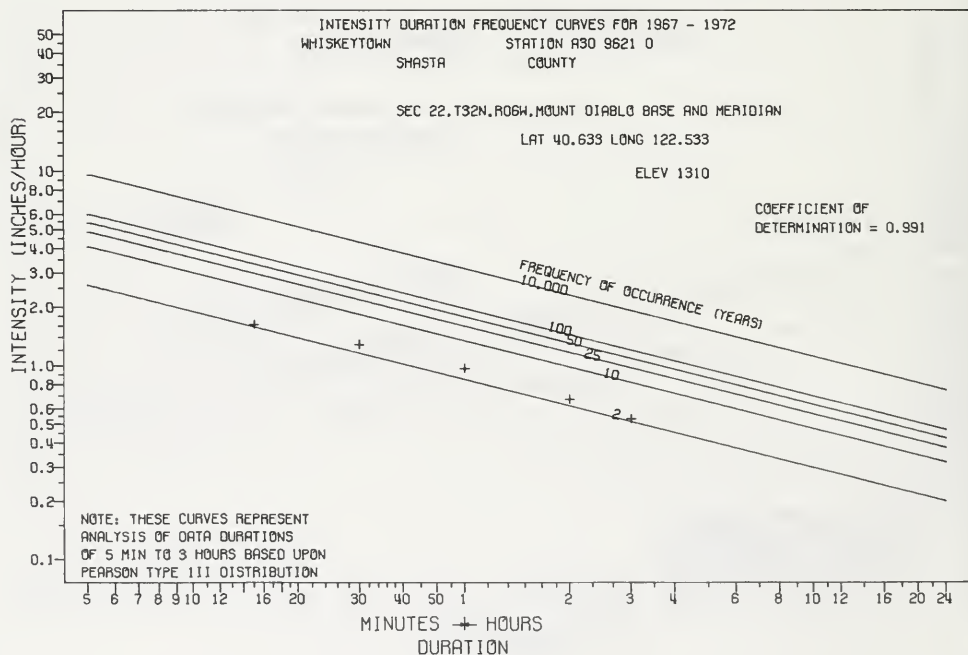
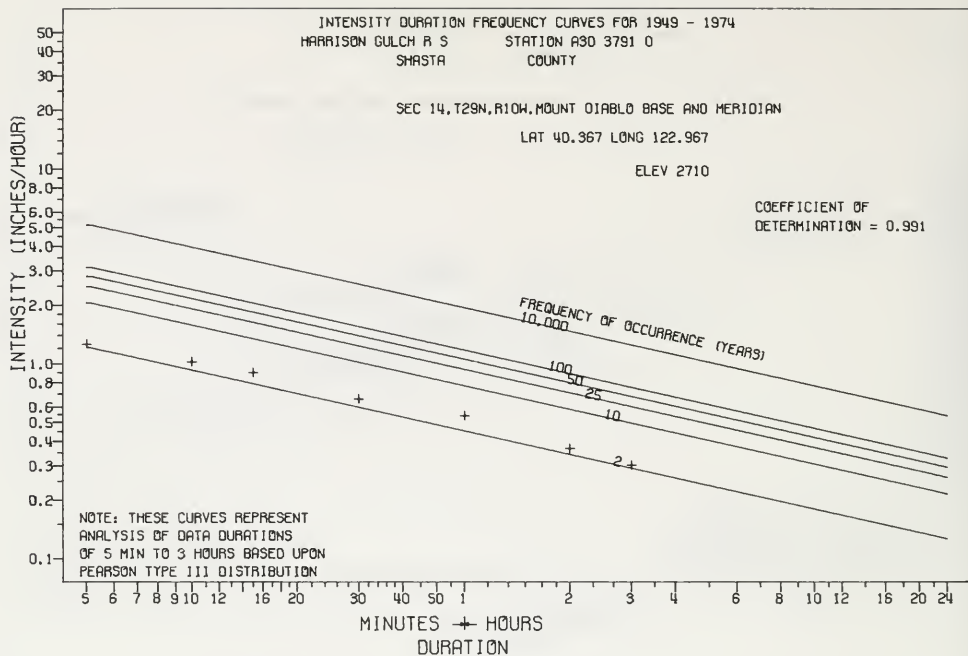


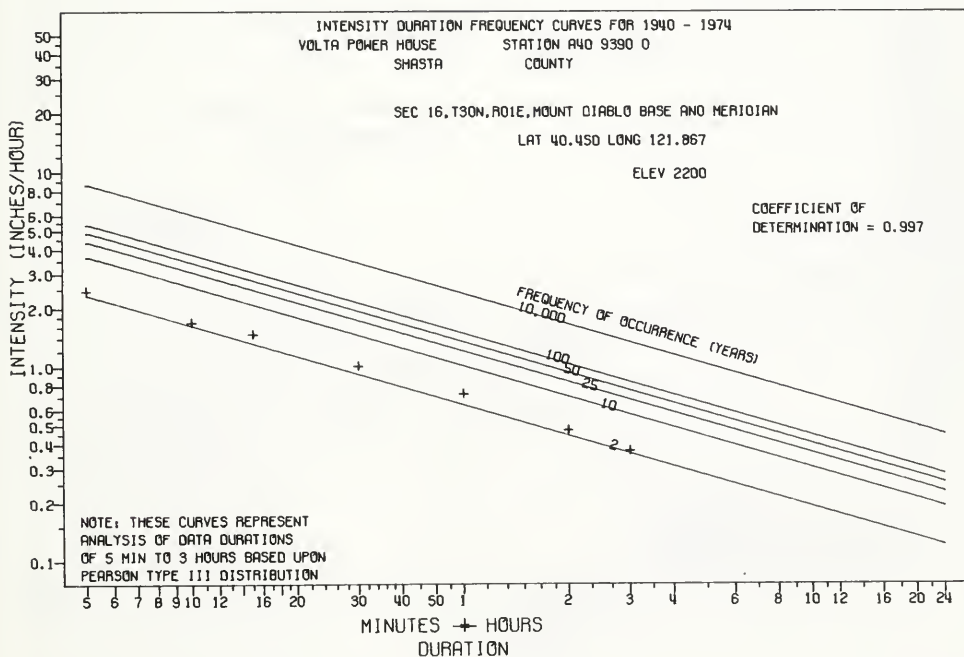
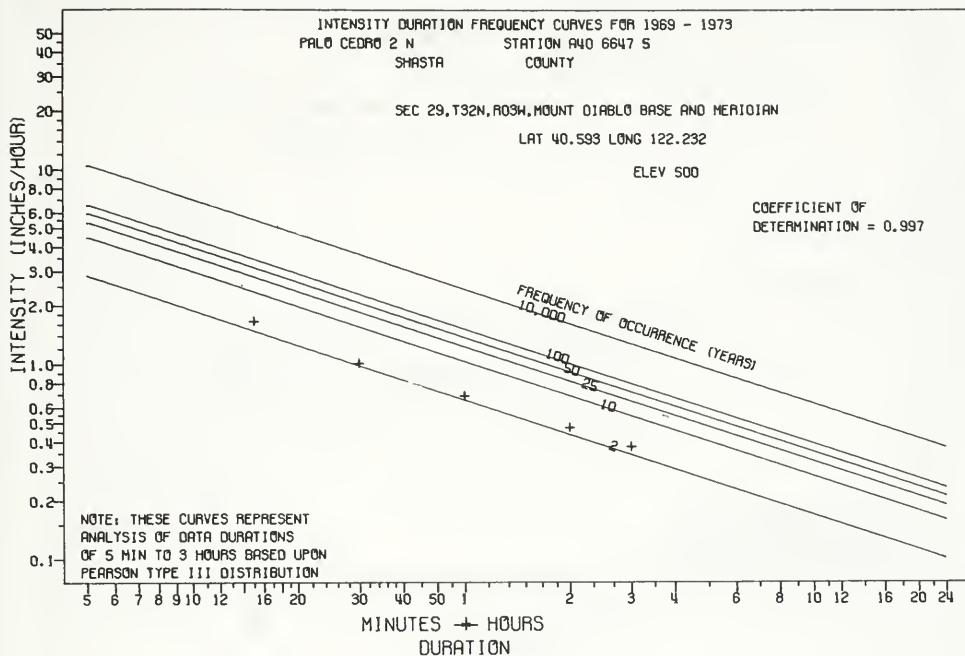




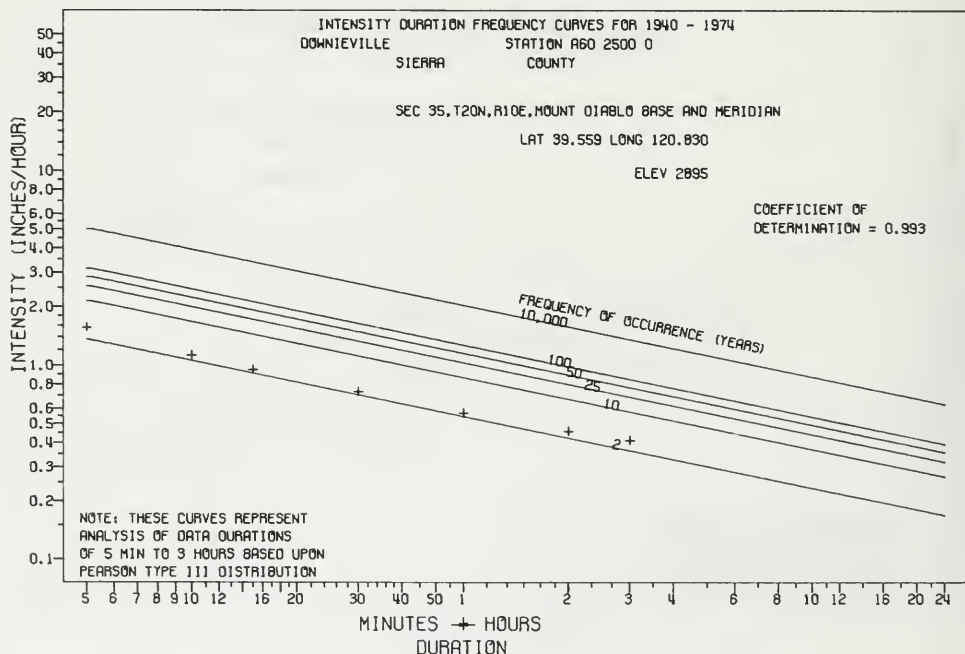
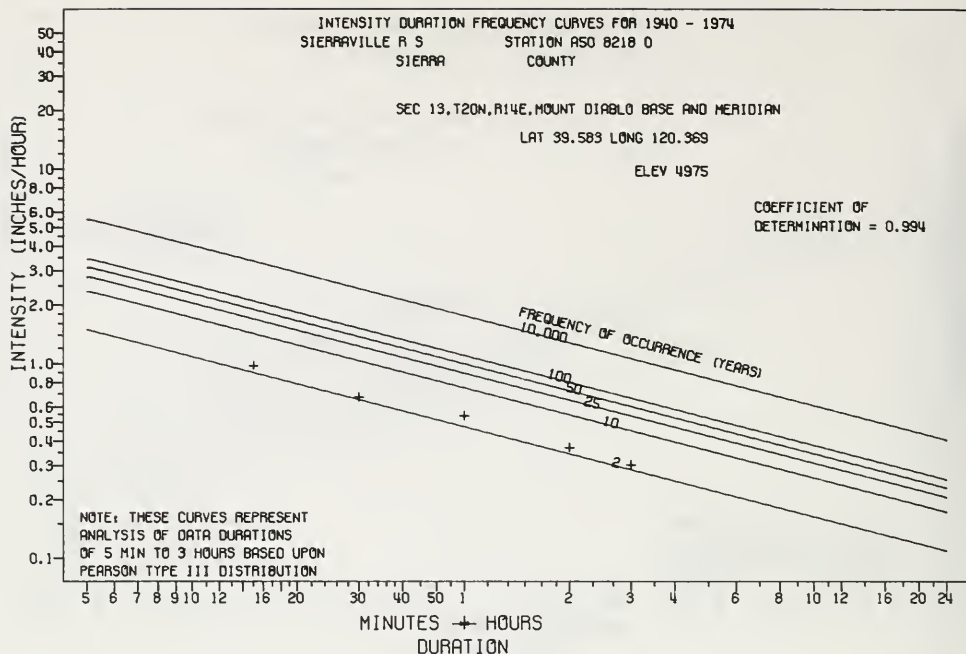














INTENSITY DURATION FREQUENCY CURVES FOR 1940 - 1975  
MOUNT SHASTA CITY N W S STATION A20 5983 0  
SISKIYOU COUNTY

LAT 41.317 LONG 122.317

ELEV 3540

COEFFICIENT OF  
DETERMINATION = 0.998

INTENSITY (INCHES/HOUR)

FREQUENCY OF OCCURRENCE (YEARS)

NOTE: THESE CURVES REPRESENT  
ANALYSIS OF DATA DURATIONS  
OF 5 MIN TO 3 HOURS BASED UPON  
PEARSON TYPE III DISTRIBUTION

MINUTES + HOURS  
DURATION

INTENSITY DURATION FREQUENCY CURVES FOR 1941 - 1974  
TULELAKE STATION F10 9053 0  
SISKIYOU COUNTY

SEC 06, T47N, R05E, MOUNT DIABLO BASE AND MERIDIAN

LAT 41.967 LONG 121.467

ELEV 4035

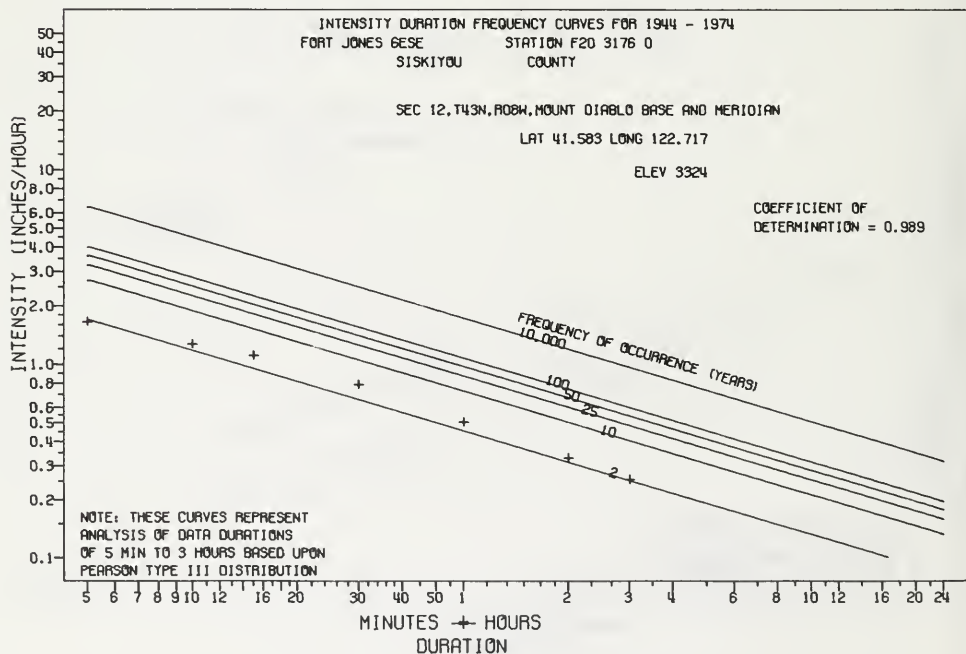
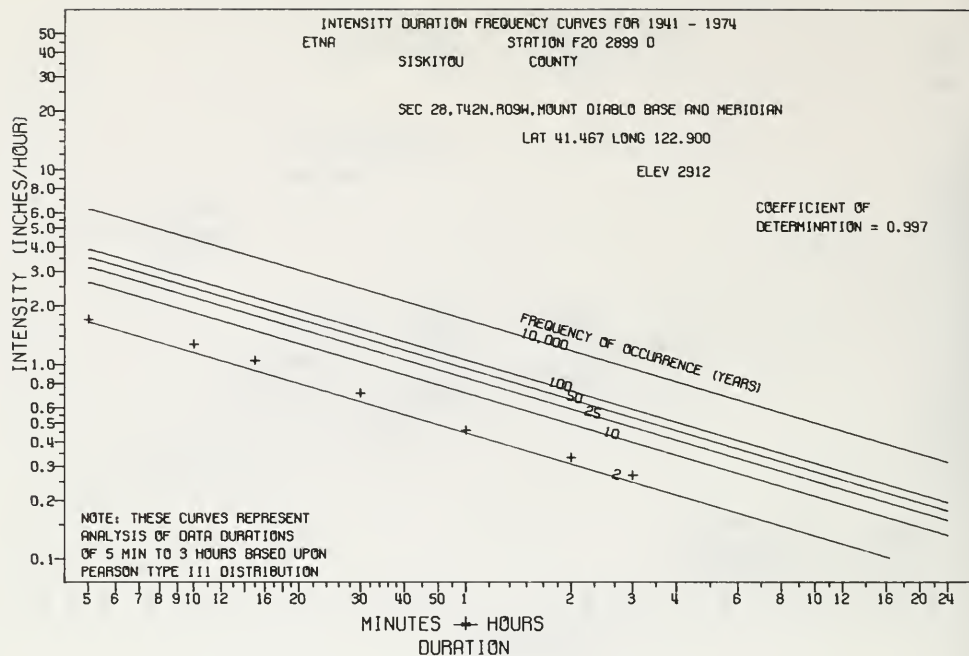
COEFFICIENT OF  
DETERMINATION = 0.991

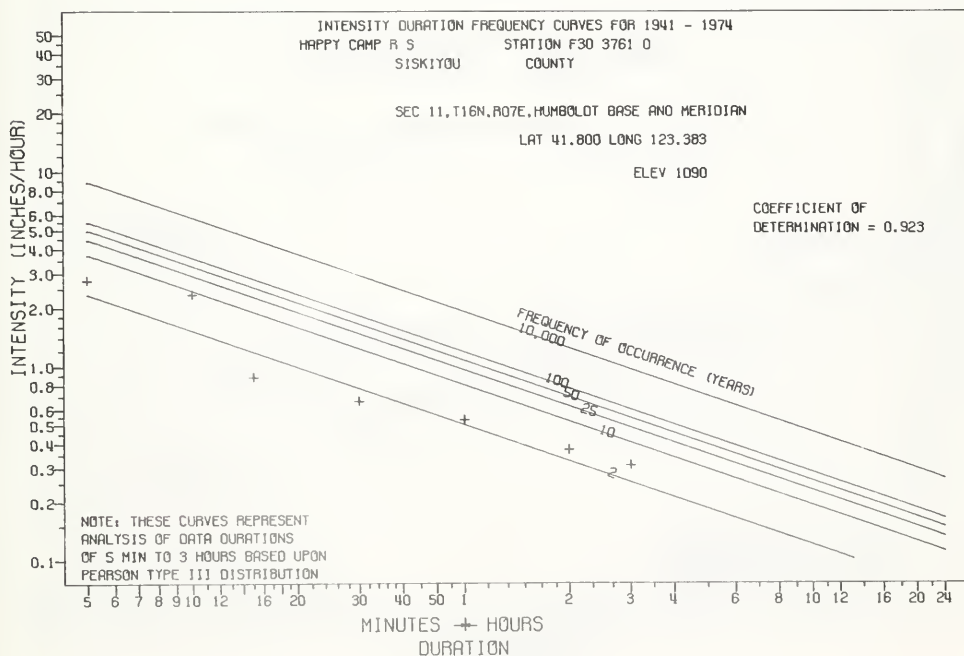
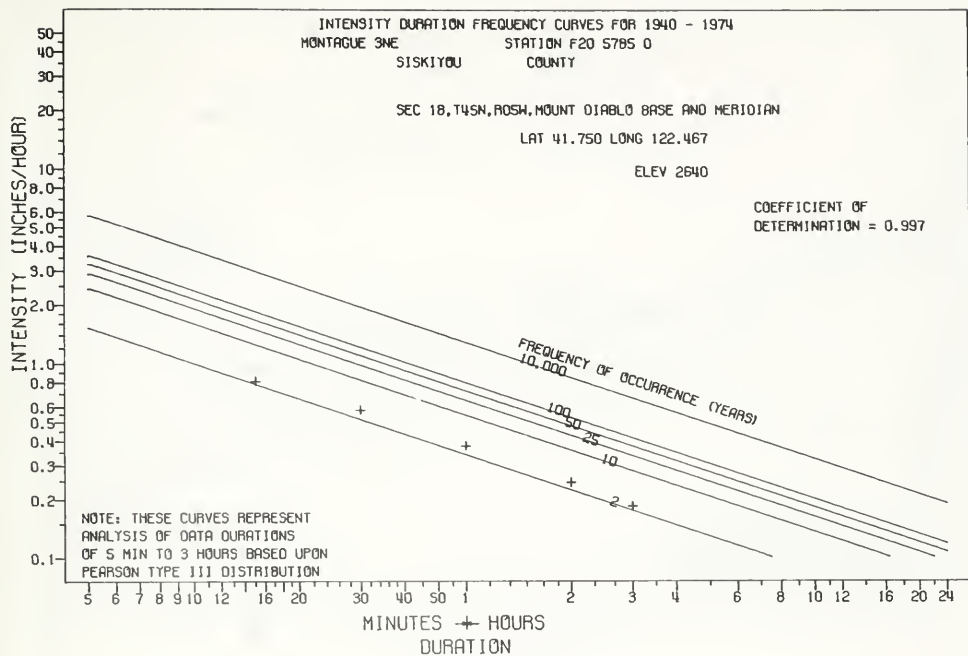
INTENSITY (INCHES/HOUR)

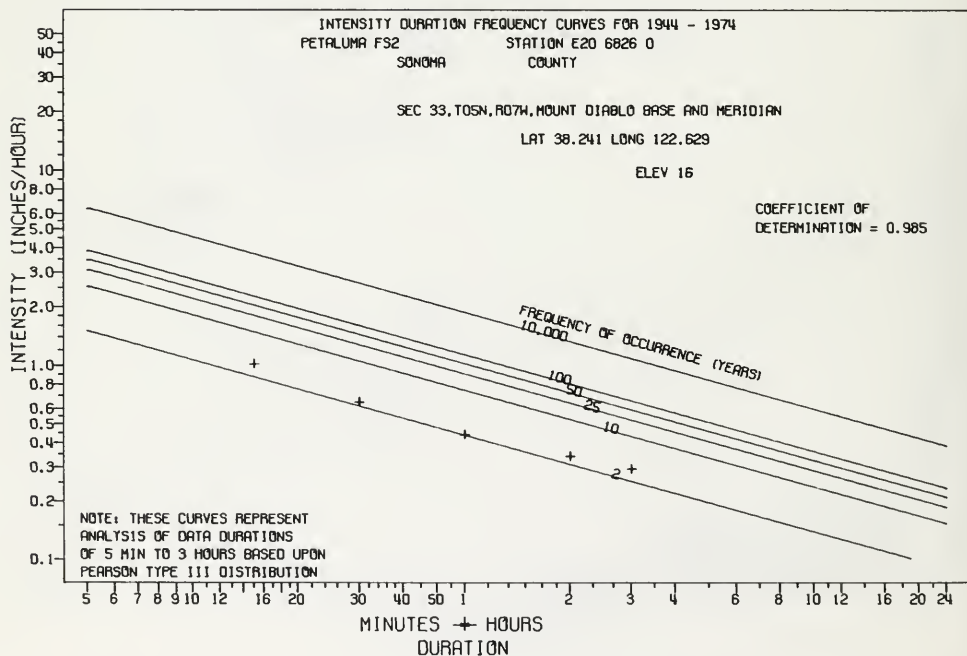
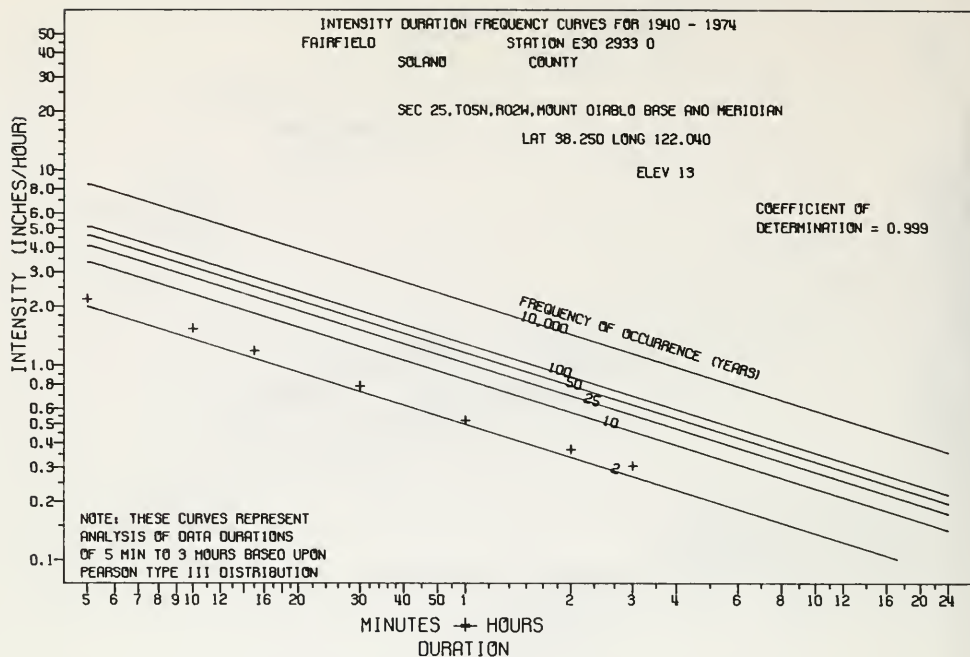
FREQUENCY OF OCCURRENCE (YEARS)

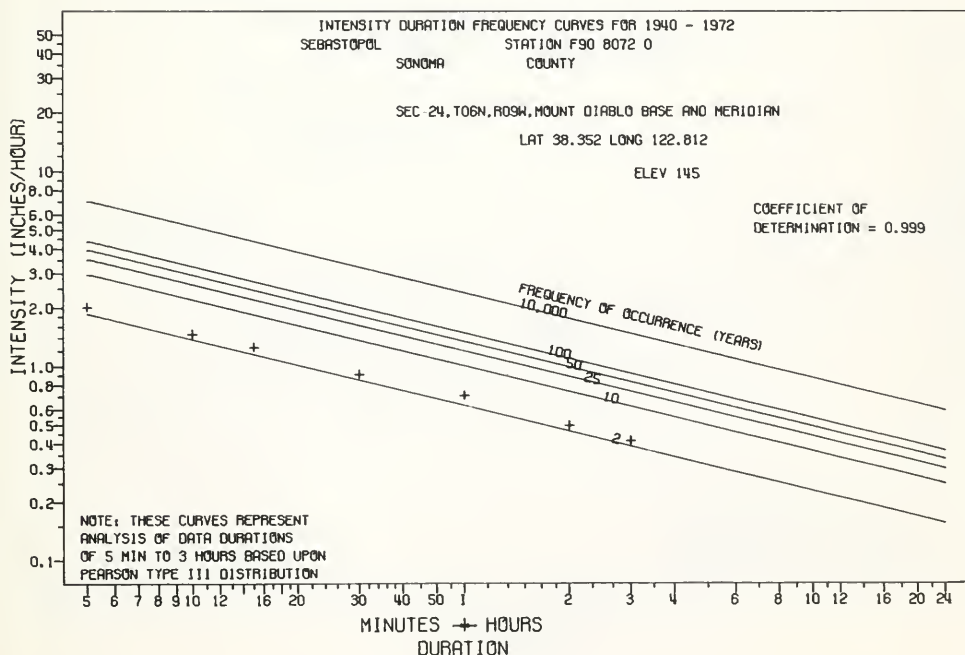
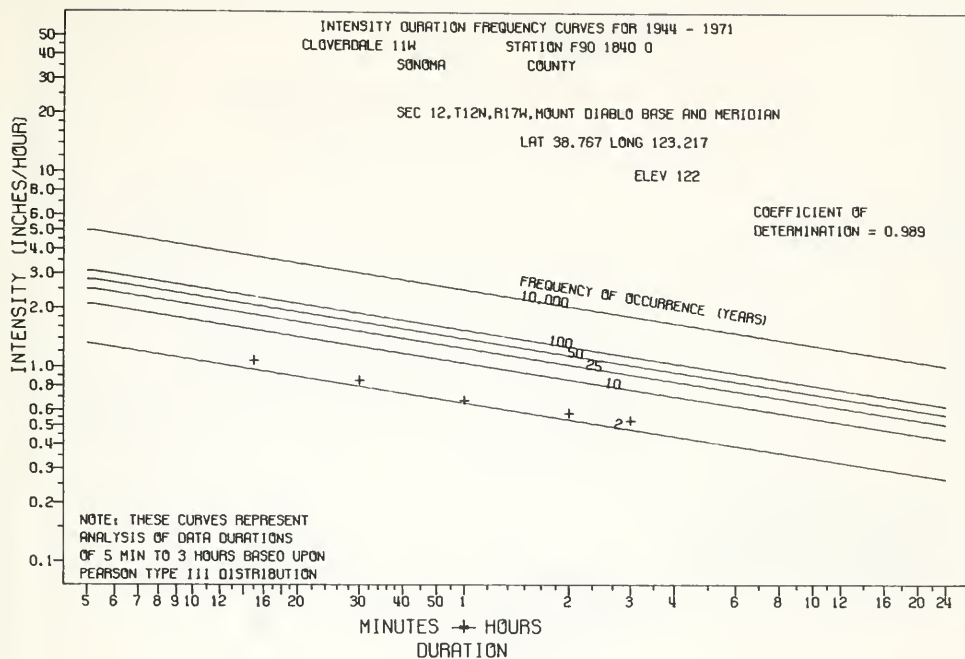
NOTE: THESE CURVES REPRESENT  
ANALYSIS OF DATA DURATIONS  
OF 5 MIN TO 3 HOURS BASED UPON  
PEARSON TYPE III DISTRIBUTION

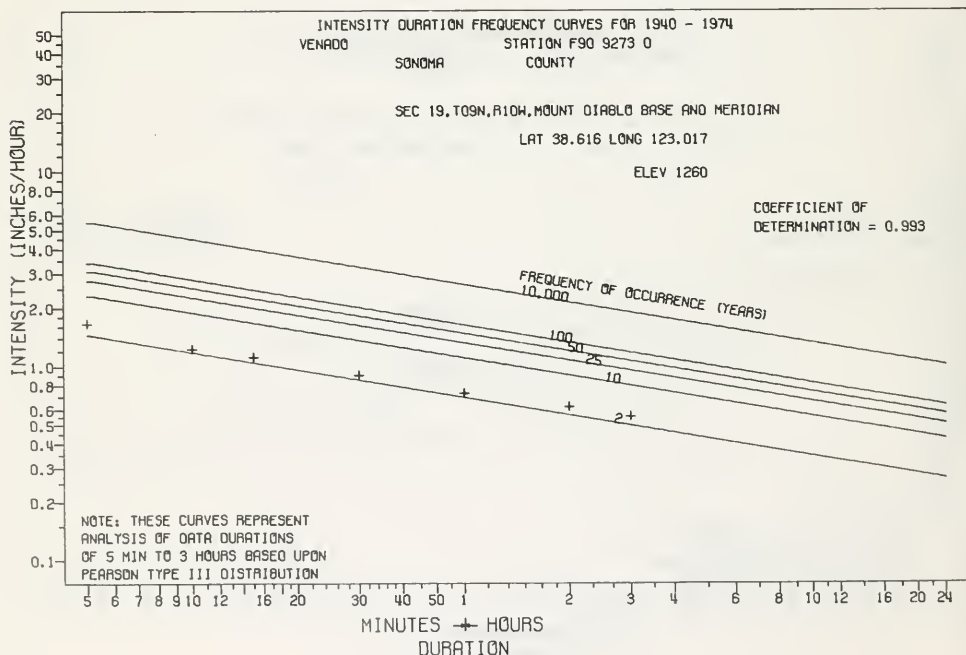
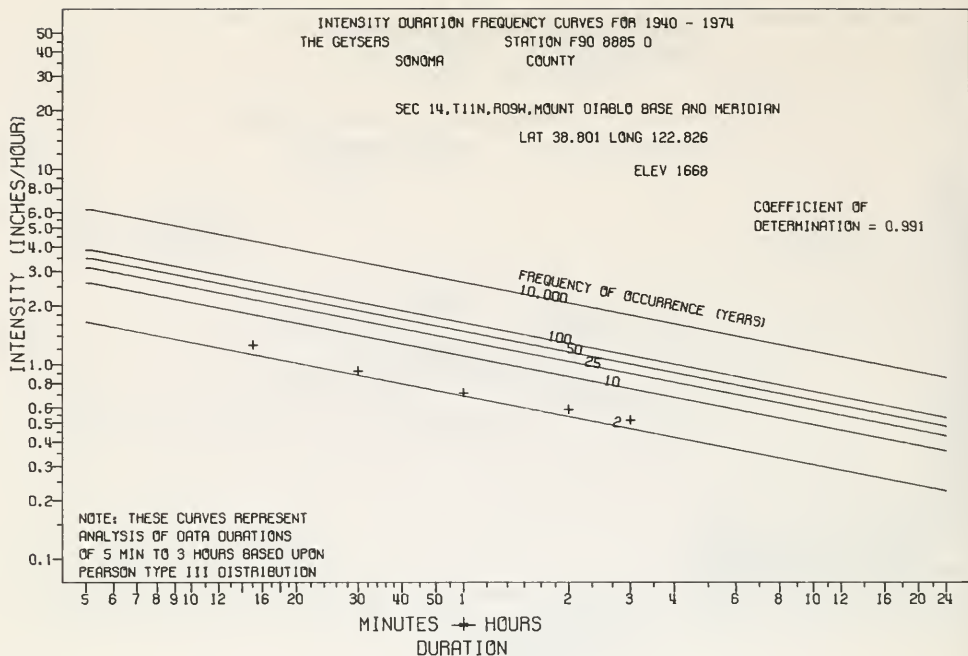
MINUTES + HOURS  
DURATION

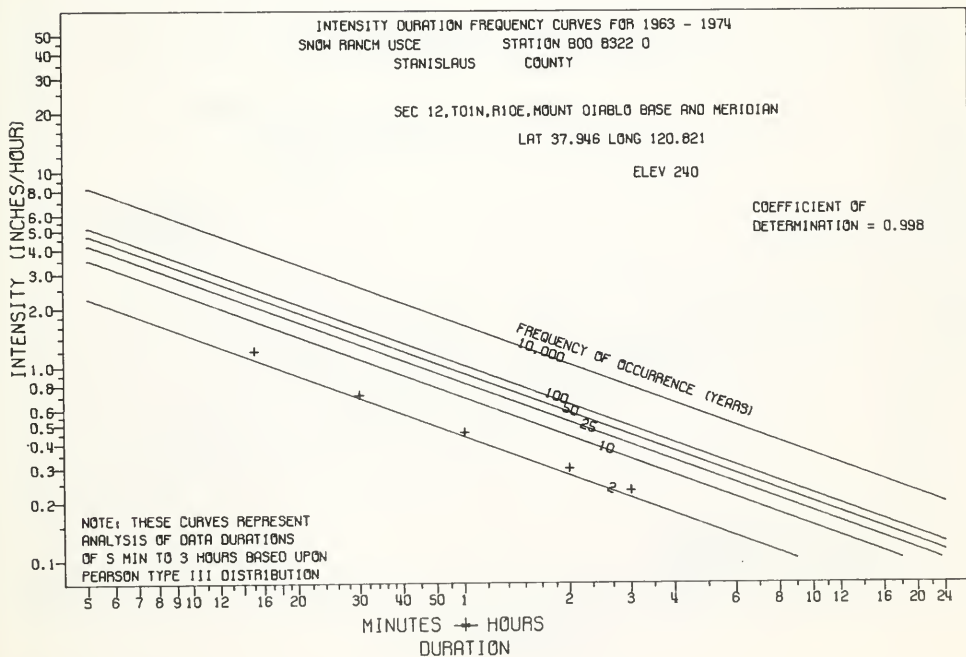
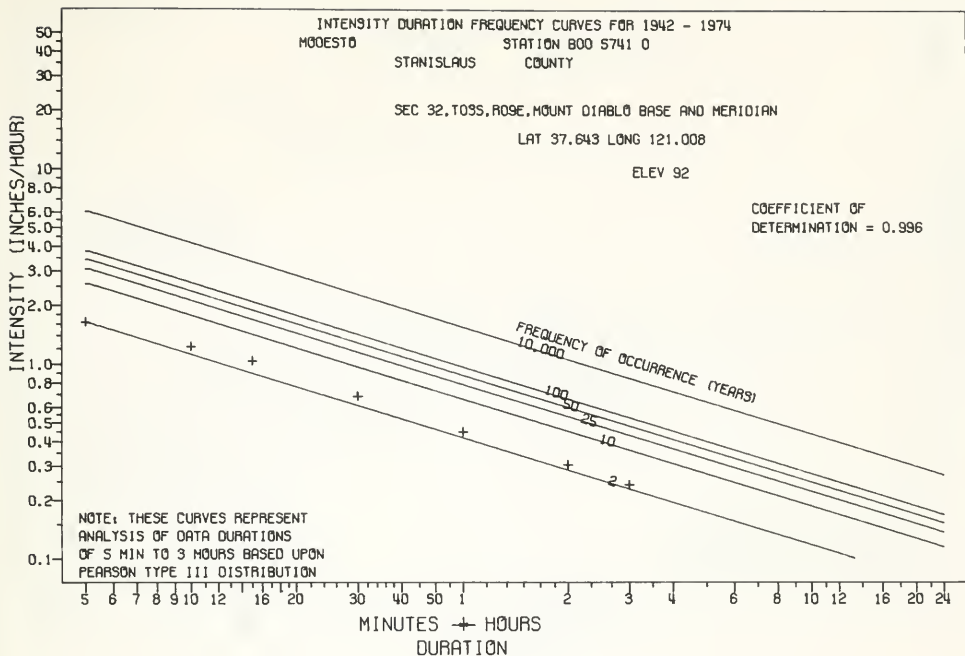




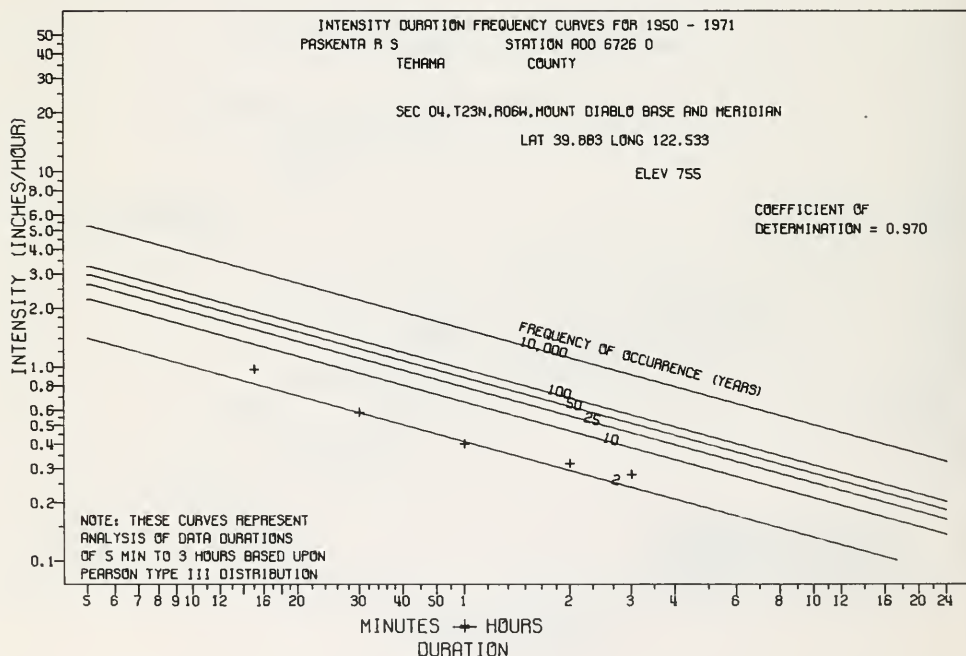
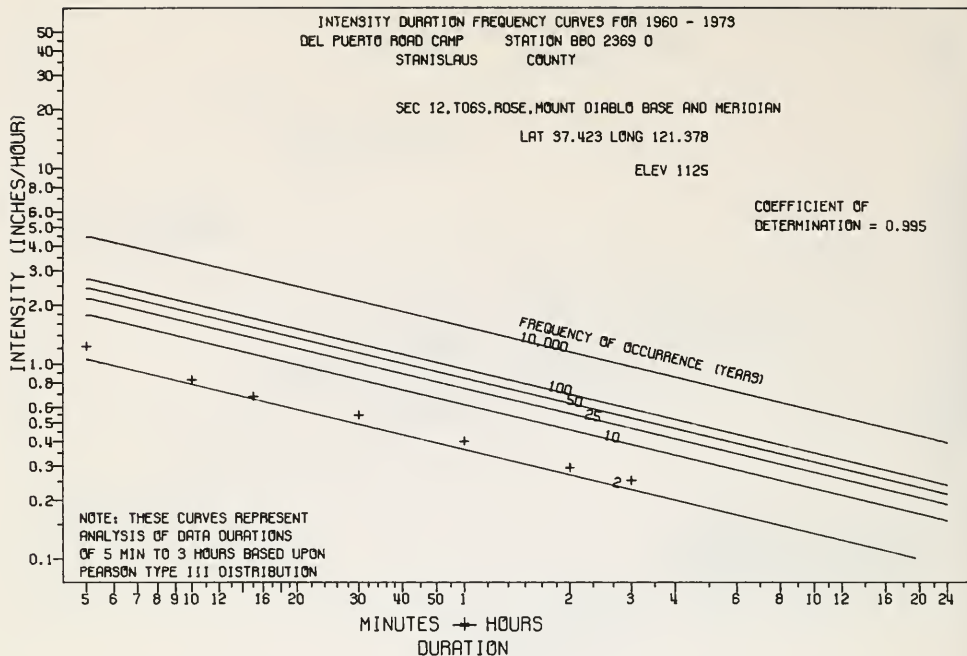




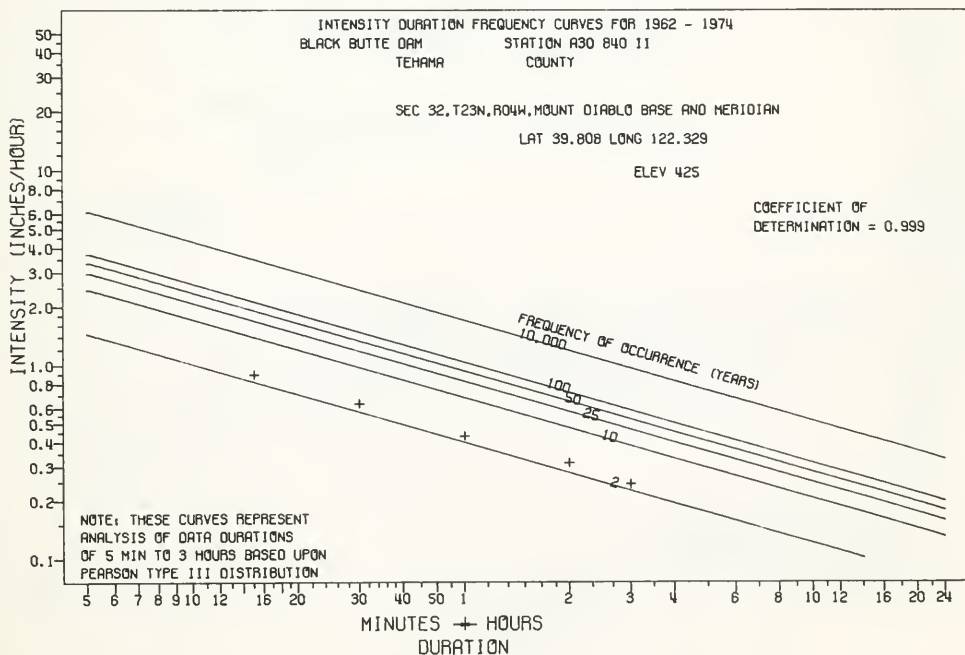
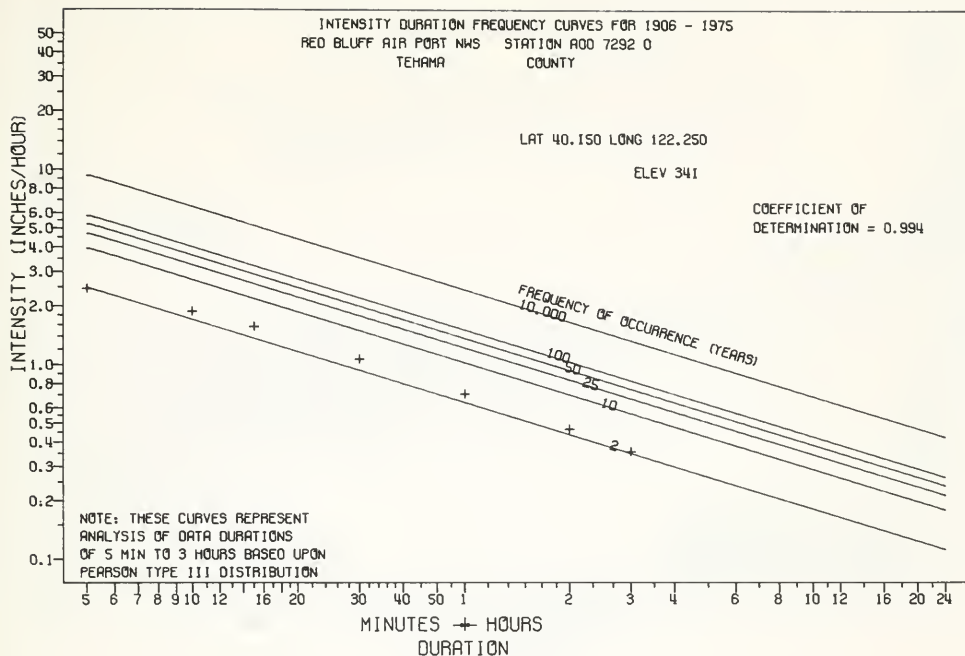


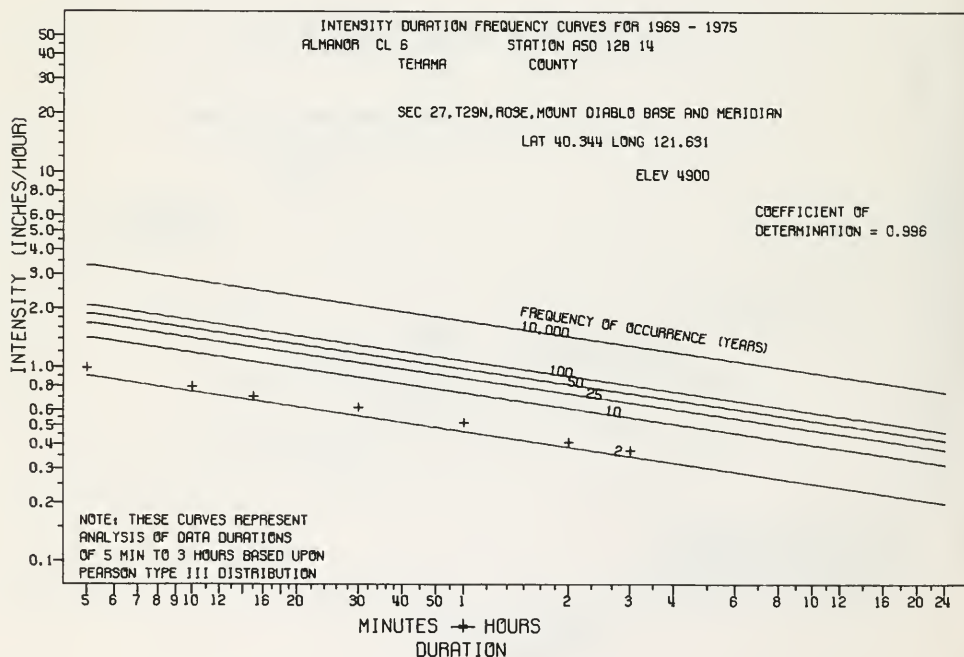
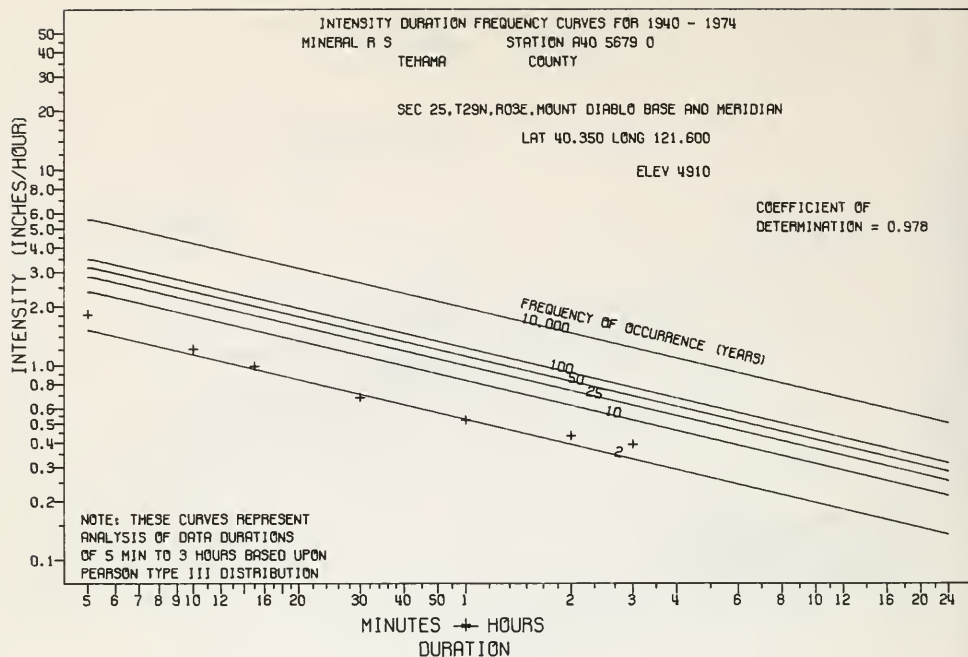


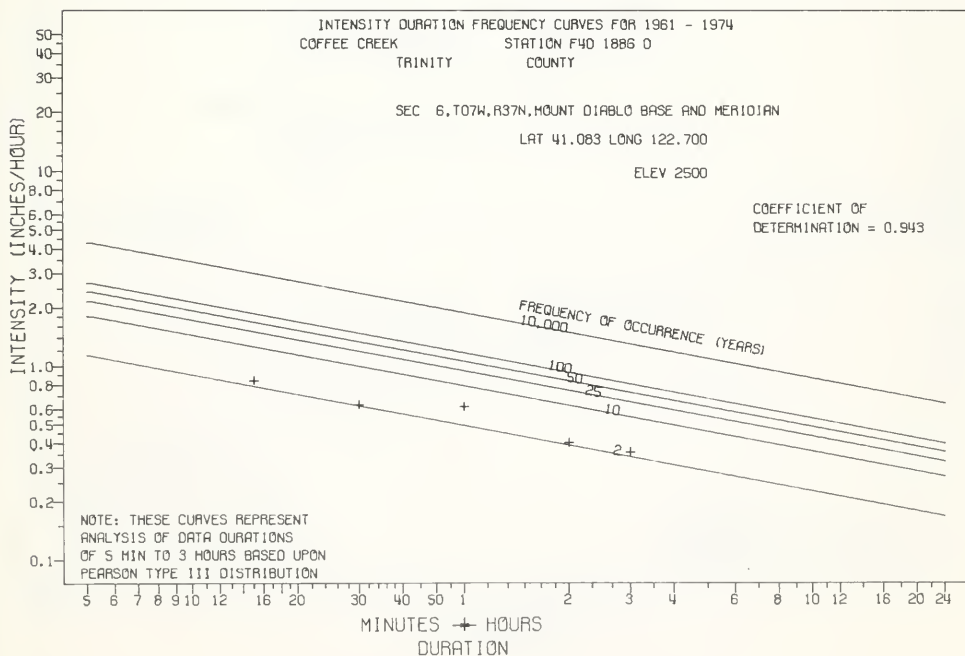
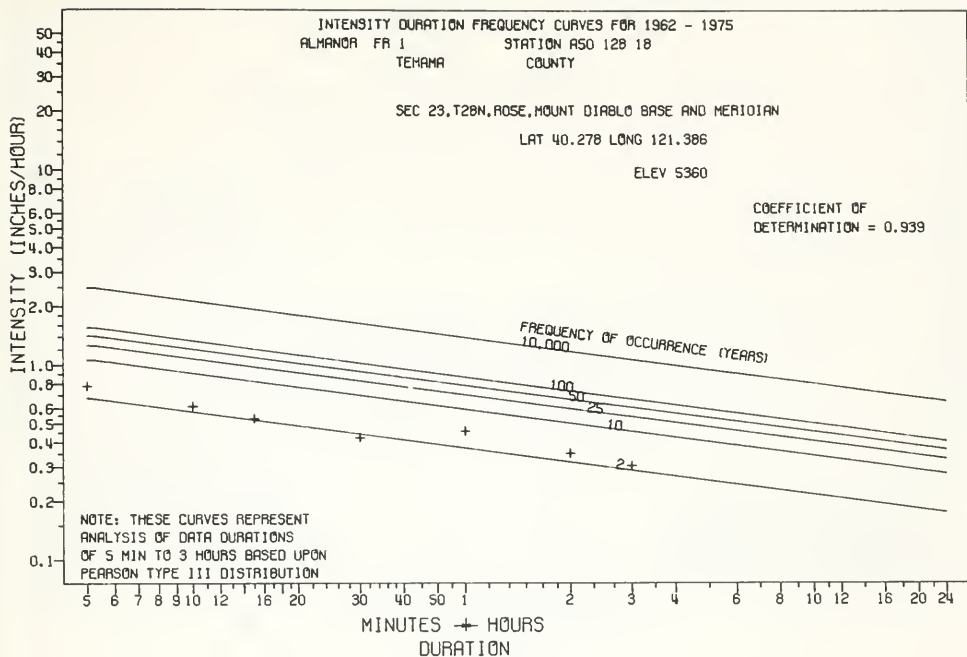


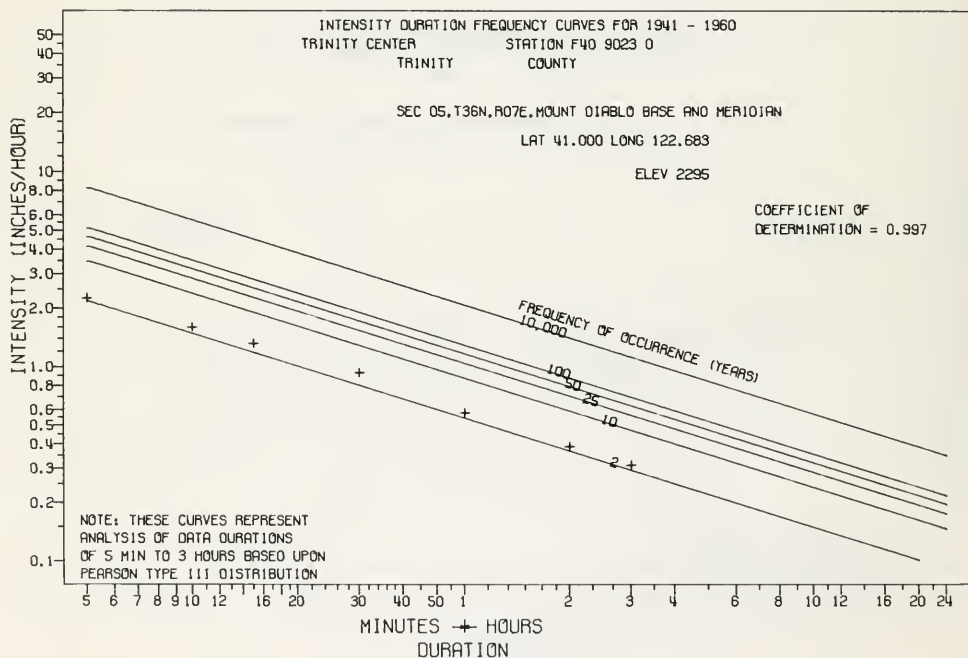
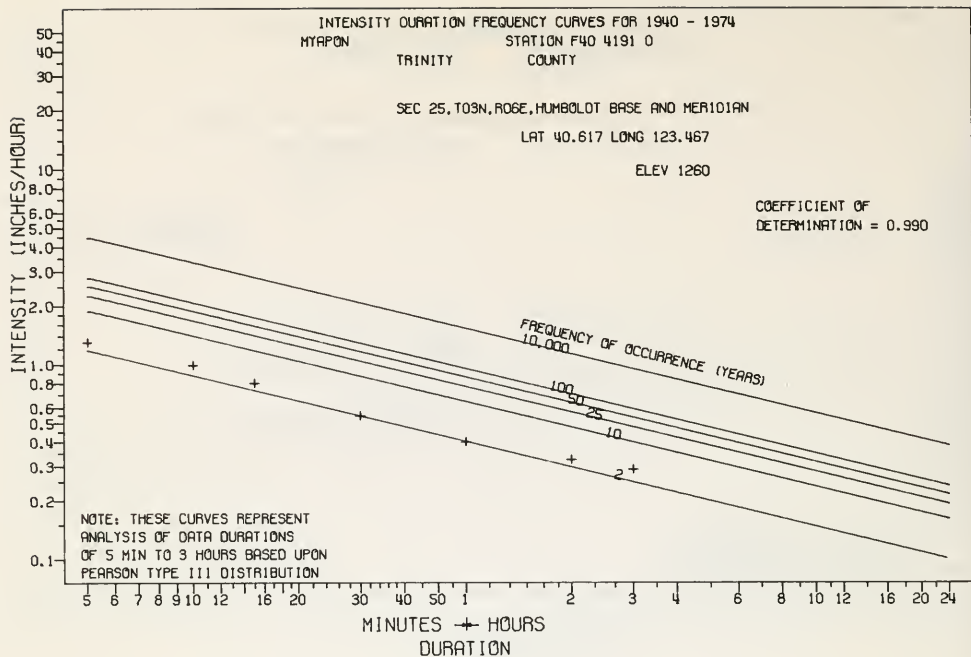


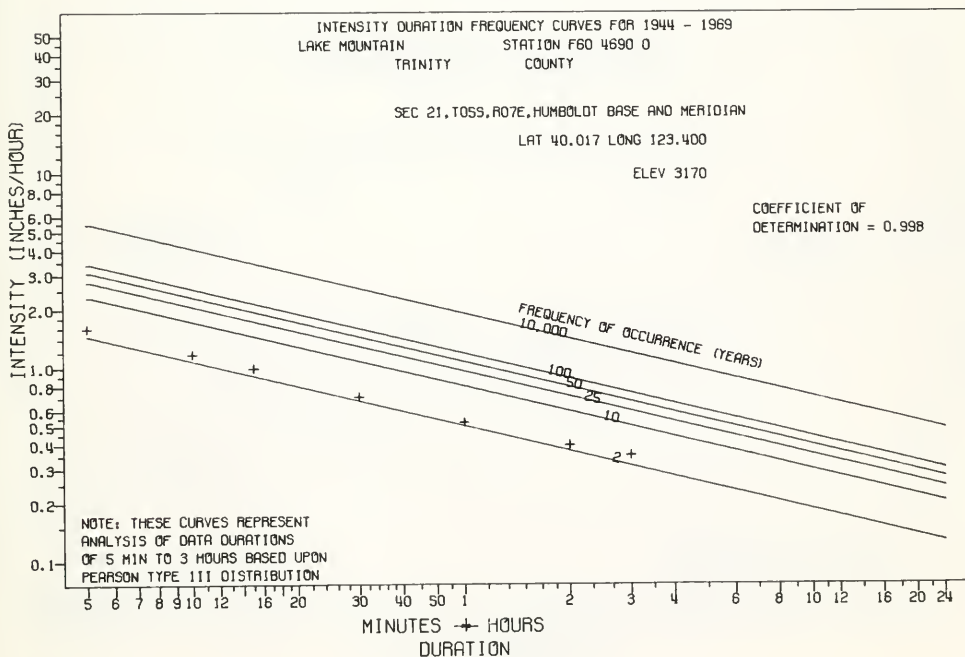
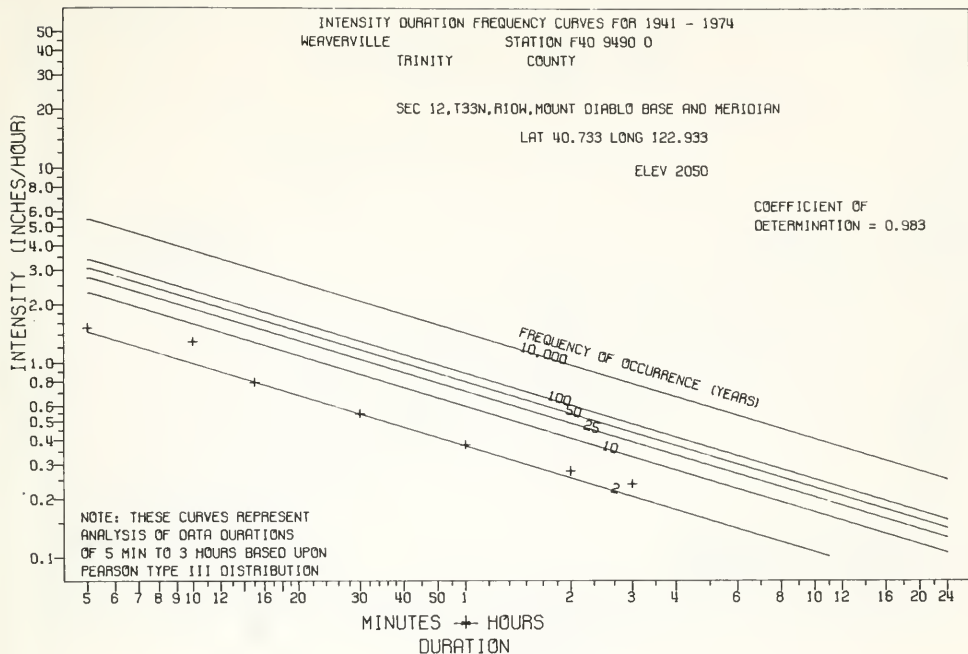


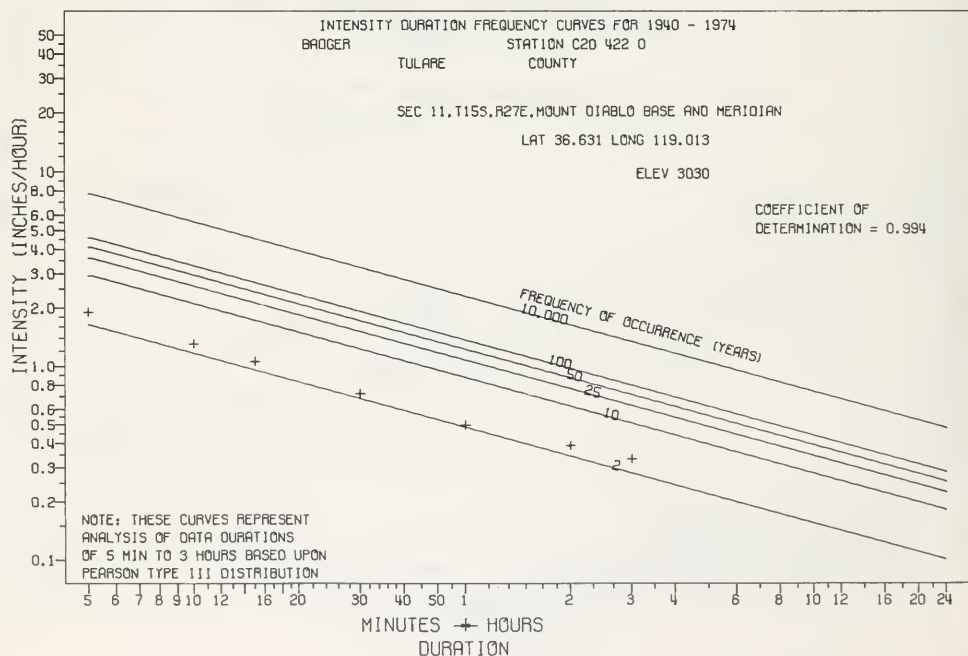
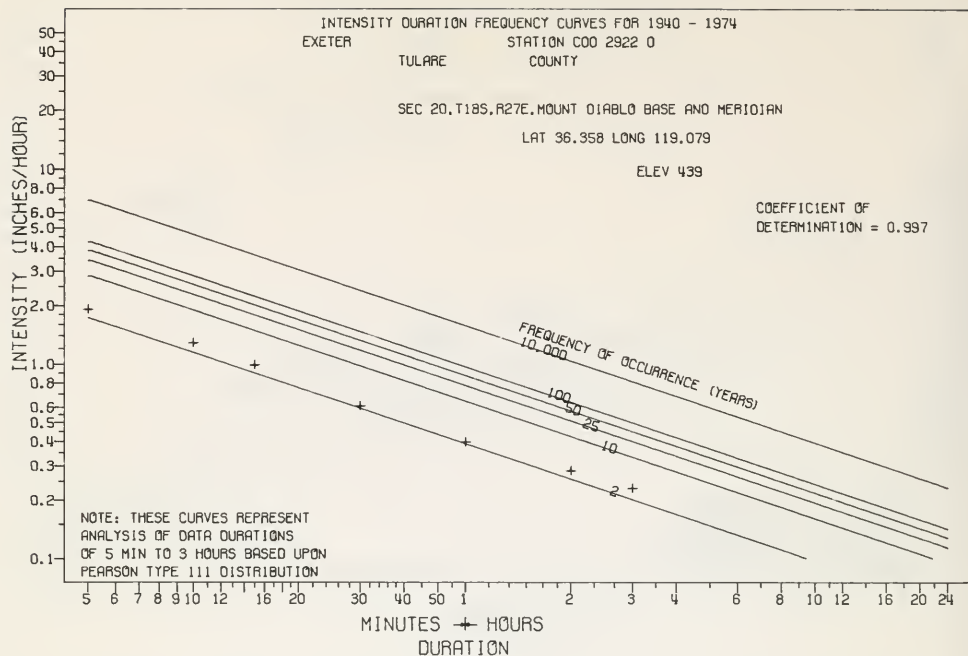












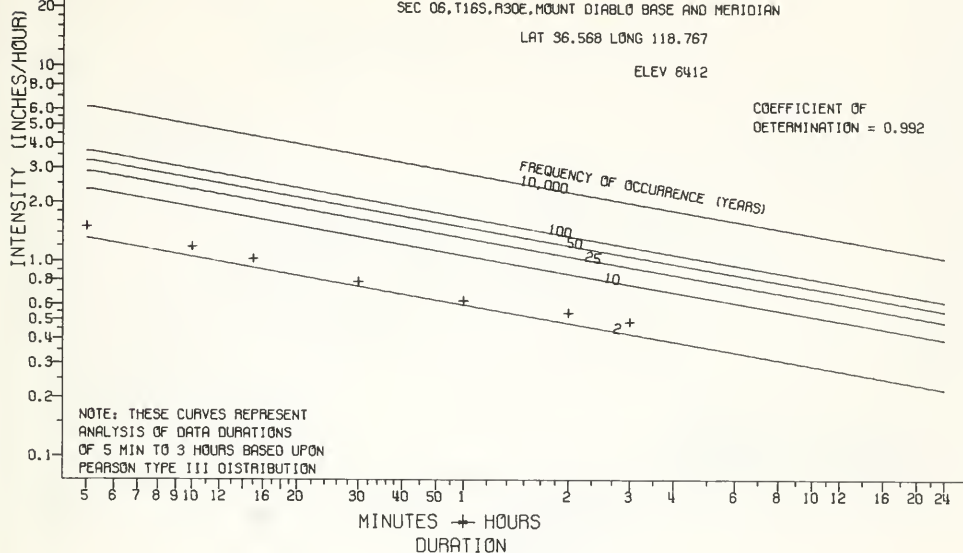
INTENSITY DURATION FREQUENCY CURVES FOR 1940 - 1968  
GIANT FOREST STATION C20 3397 0  
TULARE COUNTY

SEC 06, T16S, R30E, MOUNT DIABLO BASE AND MERIDIAN

LAT 36.568 LONG 118.767

ELEV 6412

COEFFICIENT OF  
DETERMINATION = 0.992



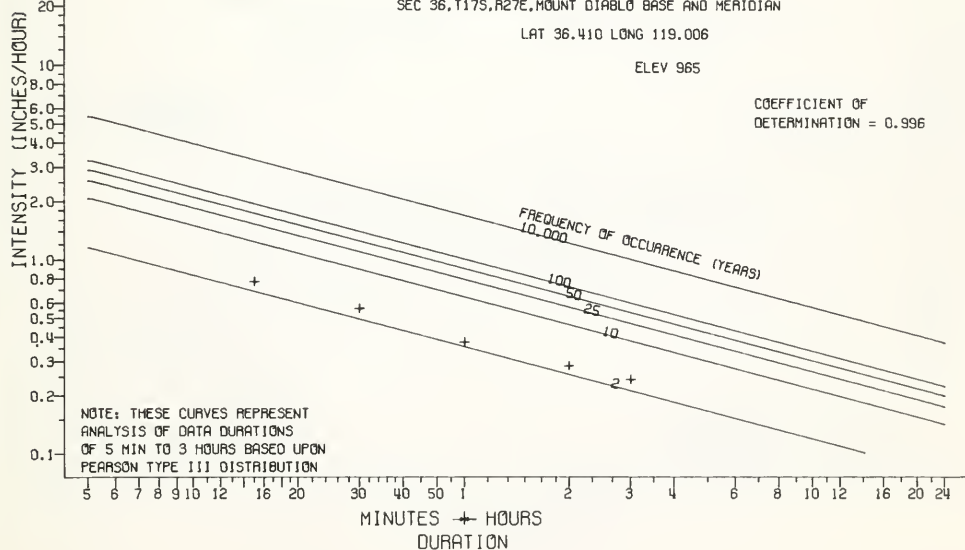
INTENSITY DURATION FREQUENCY CURVES FOR 1963 - 1974  
TERMINOUS DAM STATION C20 8868 0  
TULARE COUNTY

SEC 36, T17S, R27E, MOUNT DIABLO BASE AND MERIDIAN

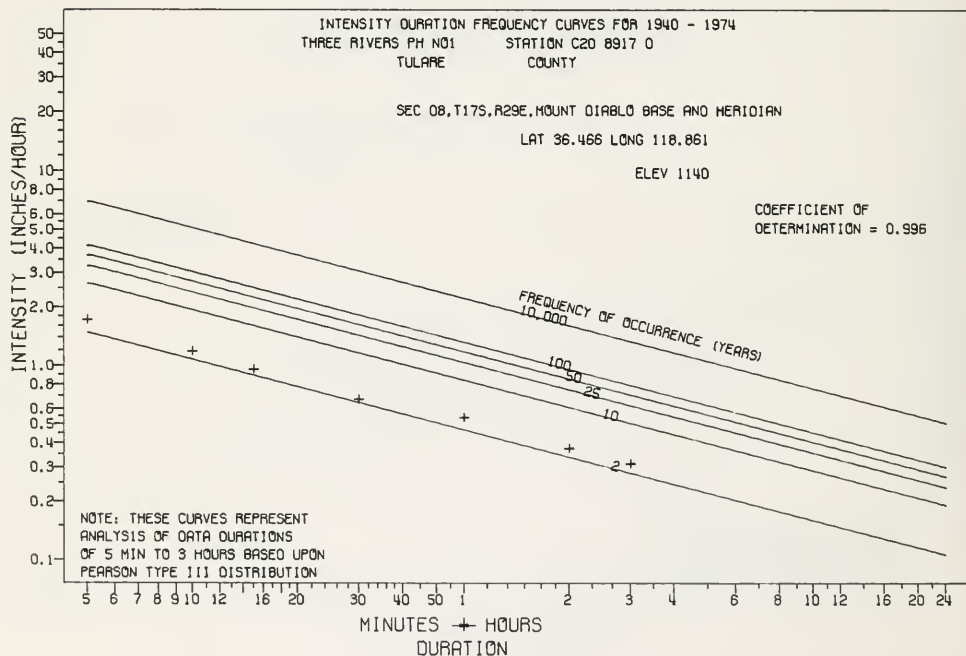
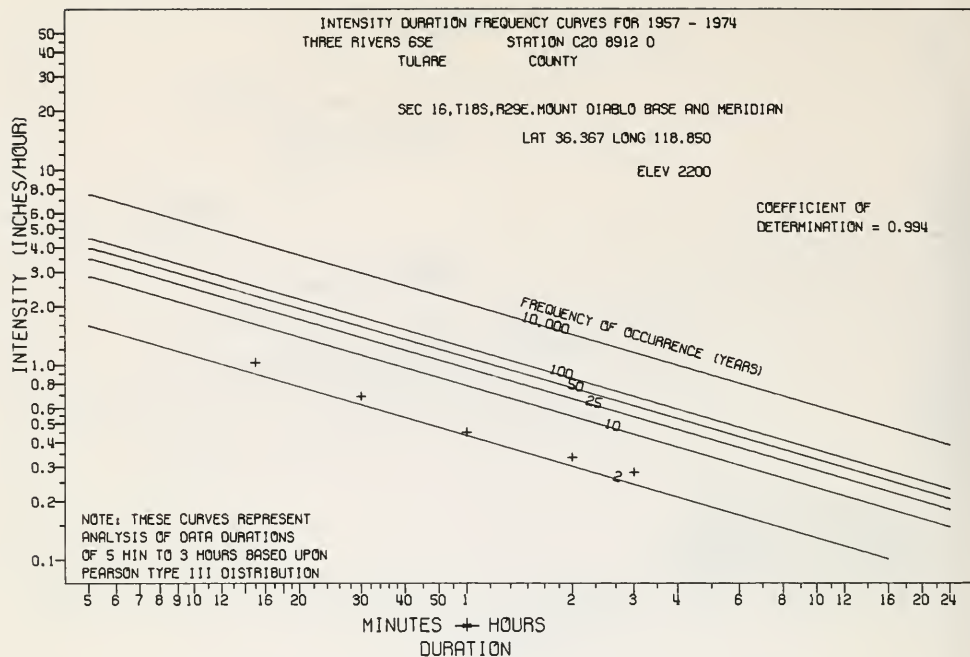
LAT 36.410 LONG 119.006

ELEV 965

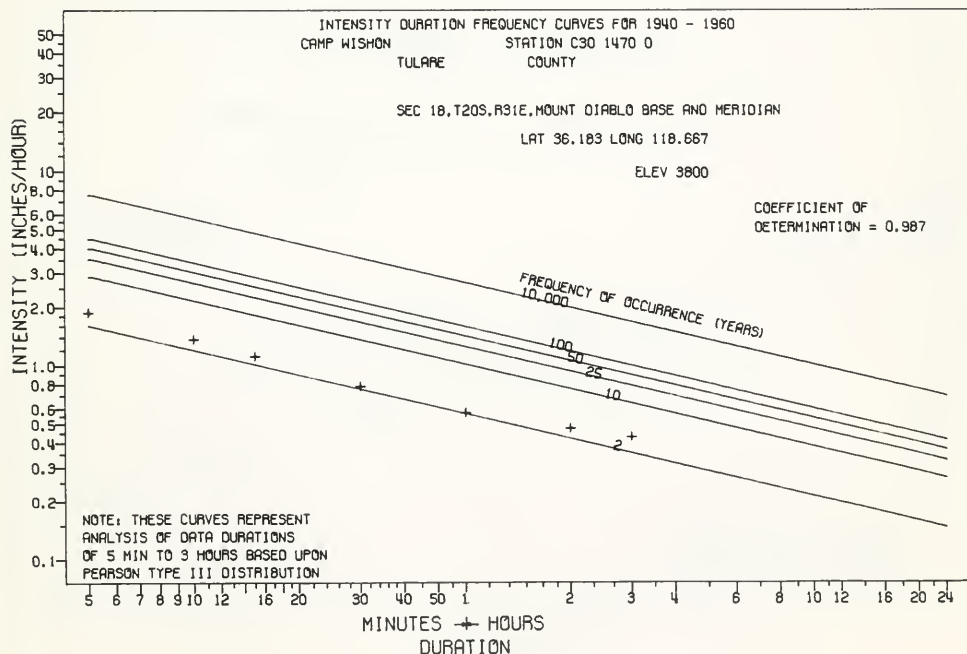
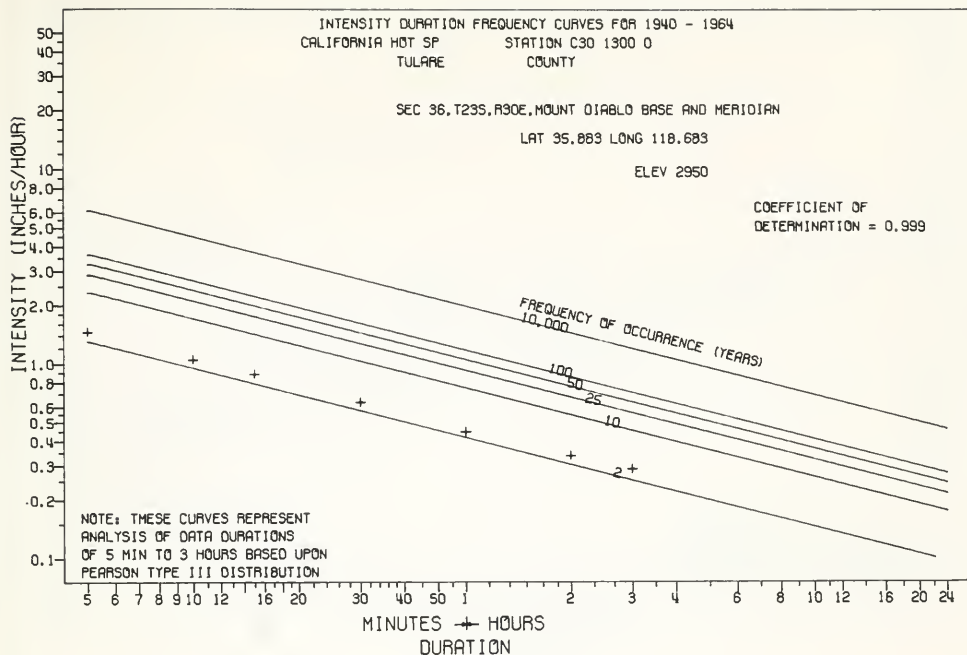
COEFFICIENT OF  
DETERMINATION = 0.996

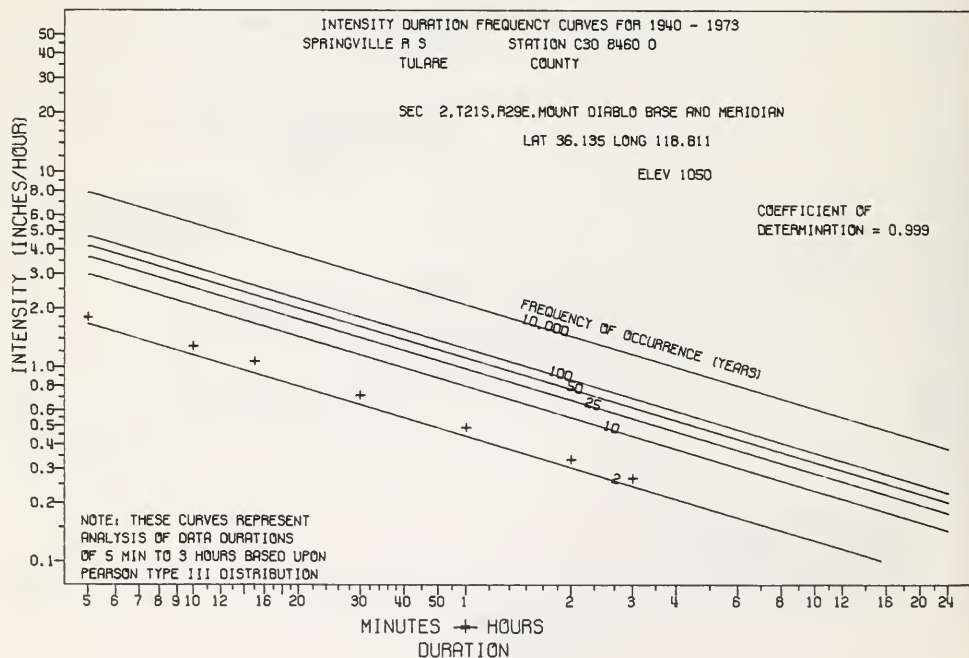
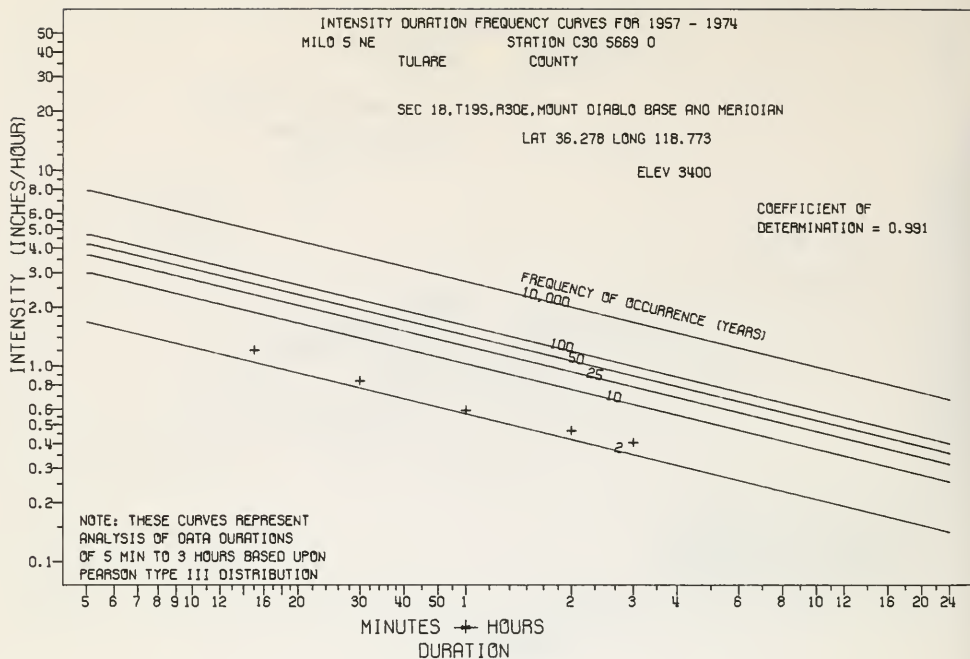


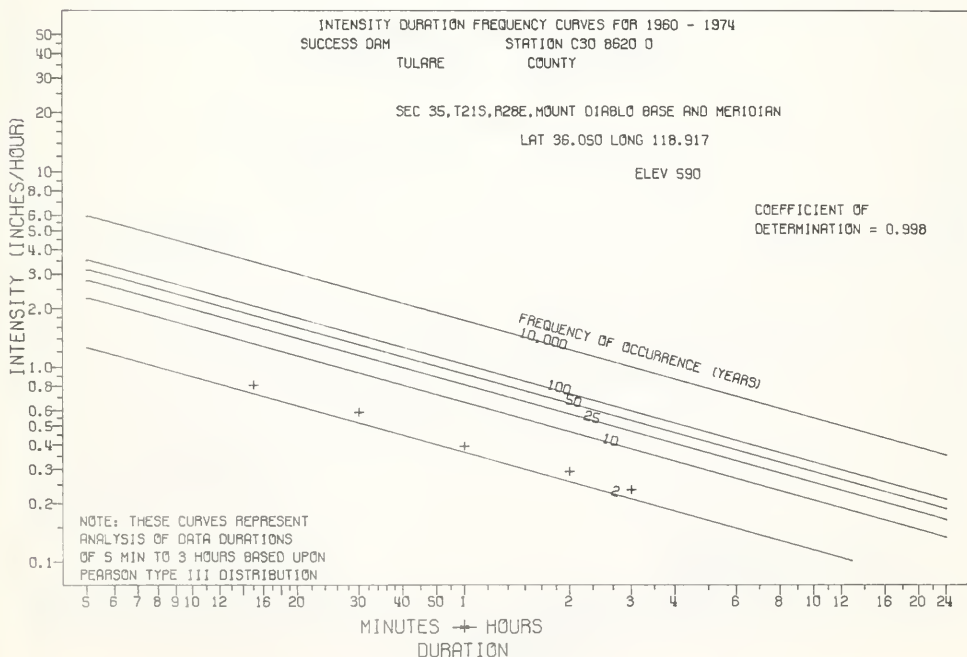
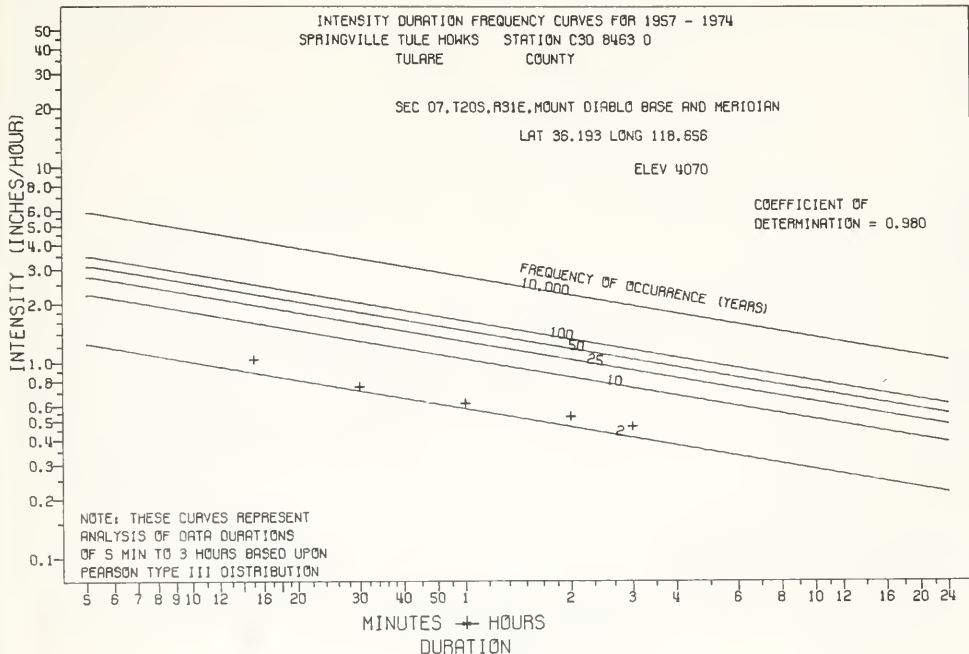


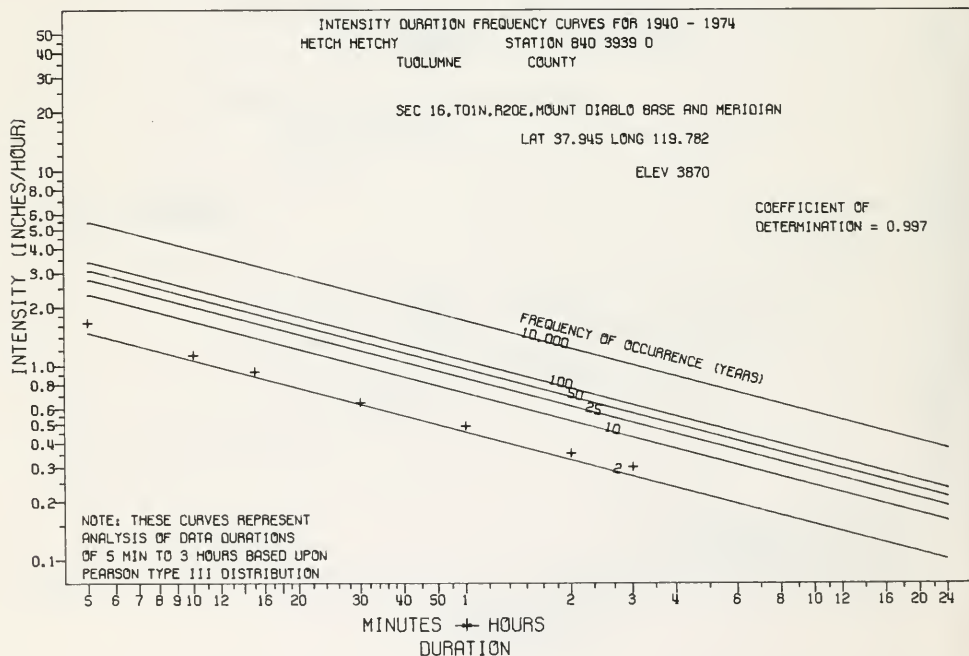
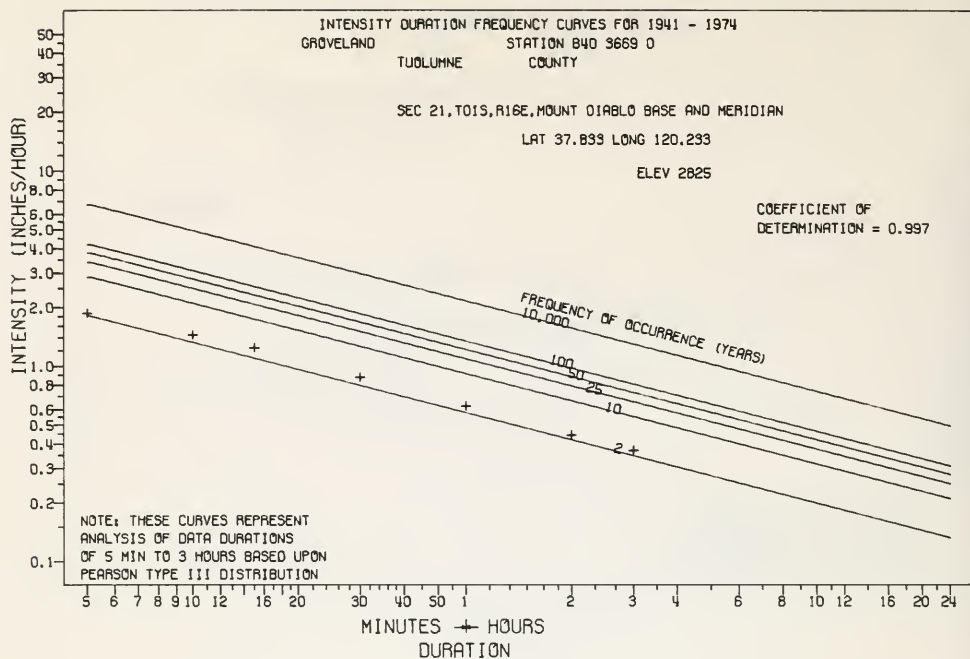


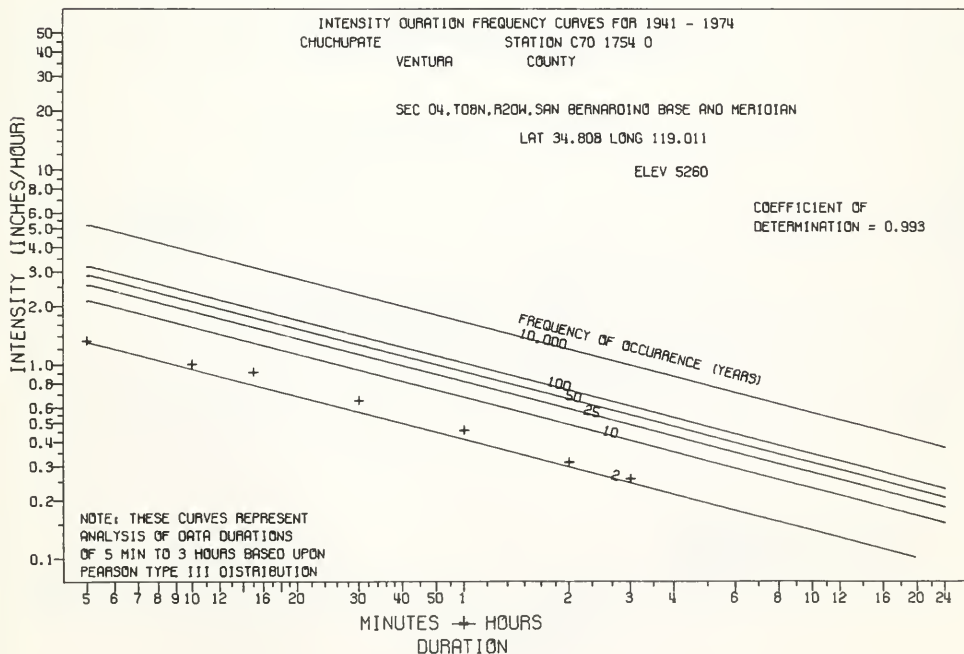
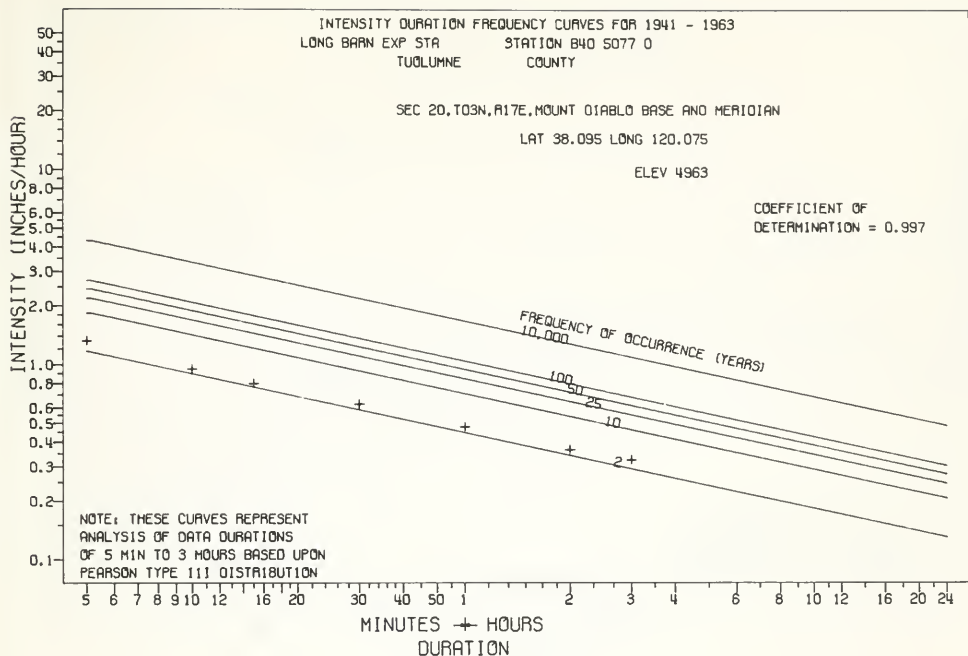


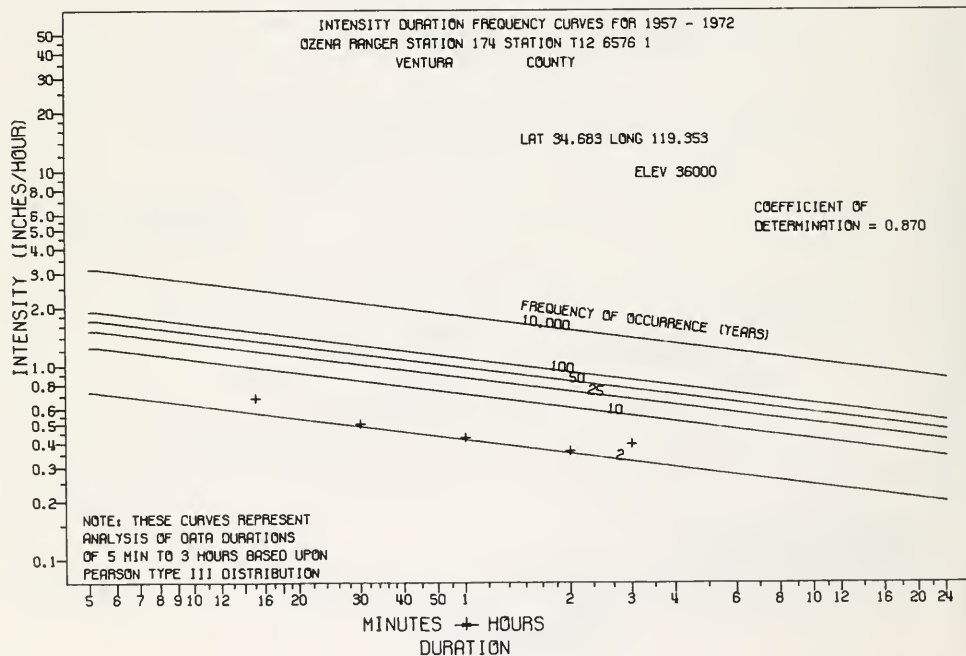
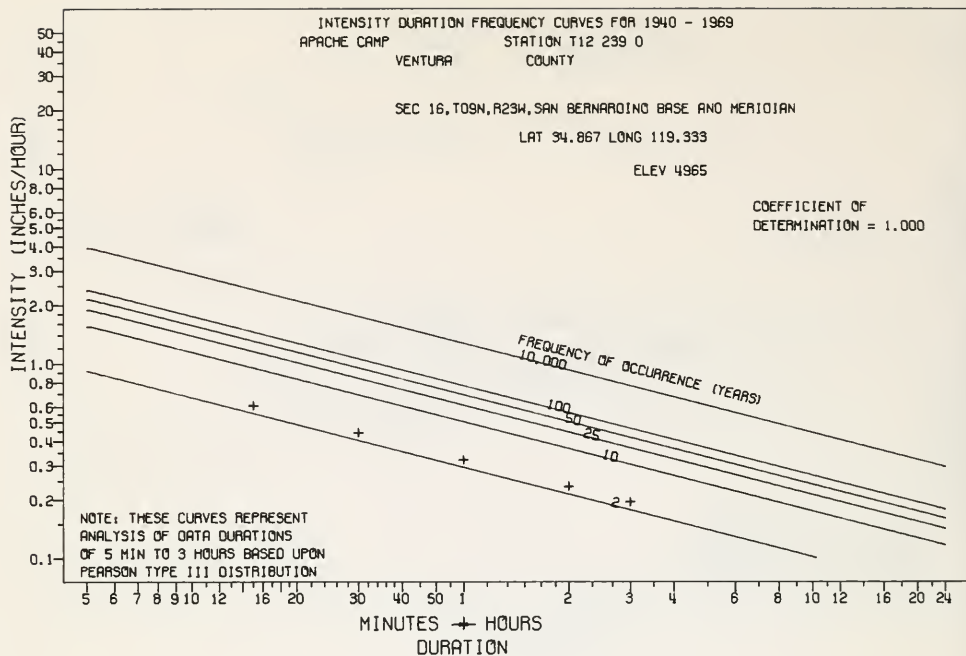












INTENSITY DURATION FREQUENCY CURVES FOR 1960 - 1974  
MATILIJIA DAM 207 STATION U02 5408 6  
VENTURA COUNTY

LAT 34.507 LONG 119.377

ELEV 1540

COEFFICIENT OF  
DETERMINATION = 0.978

INTENSITY (INCHES/HOUR)

FREQUENCY OF OCCURRENCE (YEARS)

NOTE: THESE CURVES REPRESENT  
ANALYSIS OF DATA DURATIONS  
OF 5 MIN TO 3 HOURS BASED UPON  
PEARSON TYPE III DISTRIBUTION

MINUTES + HOURS  
DURATION

INTENSITY (INCHES/HOUR)

INTENSITY DURATION FREQUENCY CURVES FOR 1957 - 1974  
SELBY RANCH 166 STATION U02 8085 2  
VENTURA COUNTY

SEC 13, T04N, R24W, SAN BERNARDINO BASE AND MERIDIAN

LAT 34.426 LONG 119.356

ELEV 660

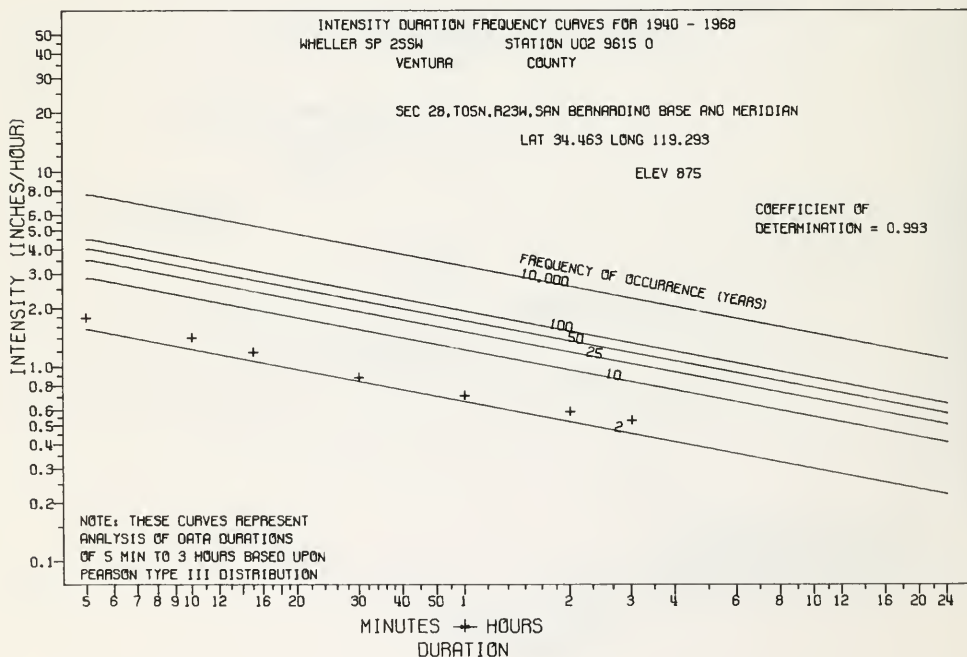
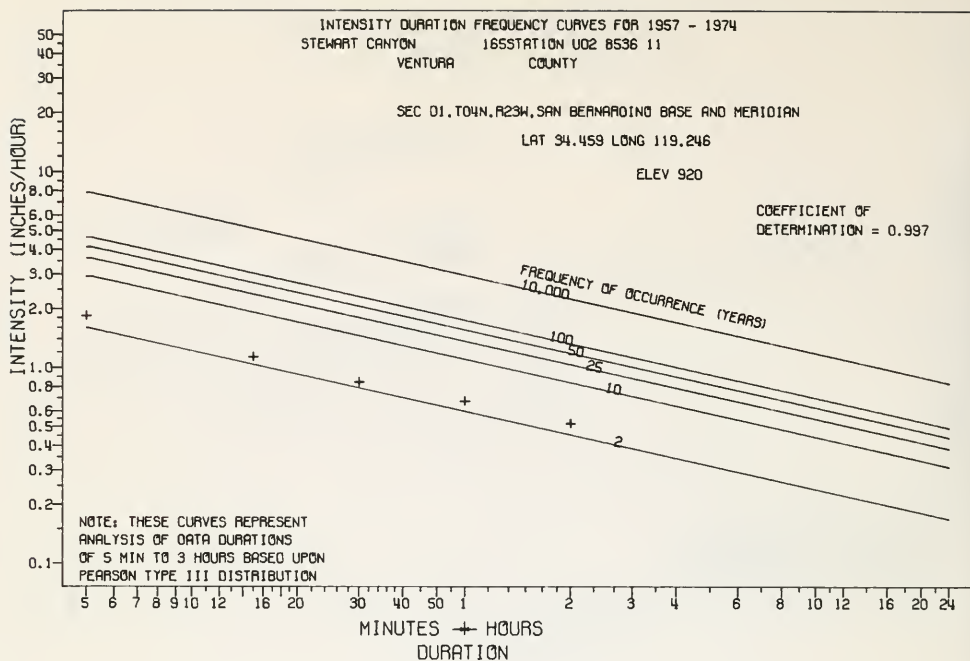
COEFFICIENT OF  
DETERMINATION = 0.987

FREQUENCY OF OCCURRENCE (YEARS)

NOTE: THESE CURVES REPRESENT  
ANALYSIS OF DATA DURATIONS  
OF 5 MIN TO 3 HOURS BASED UPON  
PEARSON TYPE III DISTRIBUTION

MINUTES + HOURS  
DURATION





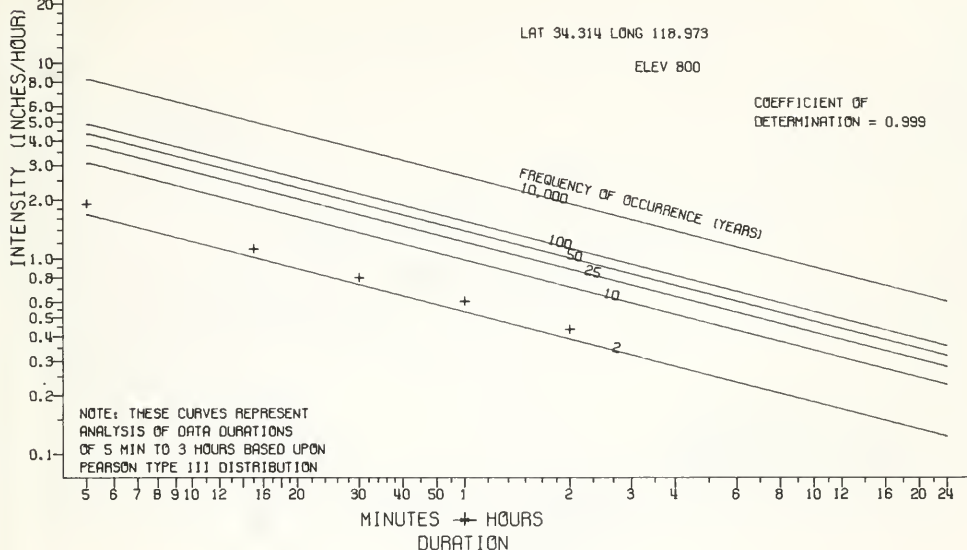


INTENSITY DURATION FREQUENCY CURVES FOR 1961 - 1974  
BALCON CANYON 206 STATION U03 450 18  
VENTURA COUNTY

LAT 34.314 LONG 118.973

ELEV 800

COEFFICIENT OF  
DETERMINATION = 0.999



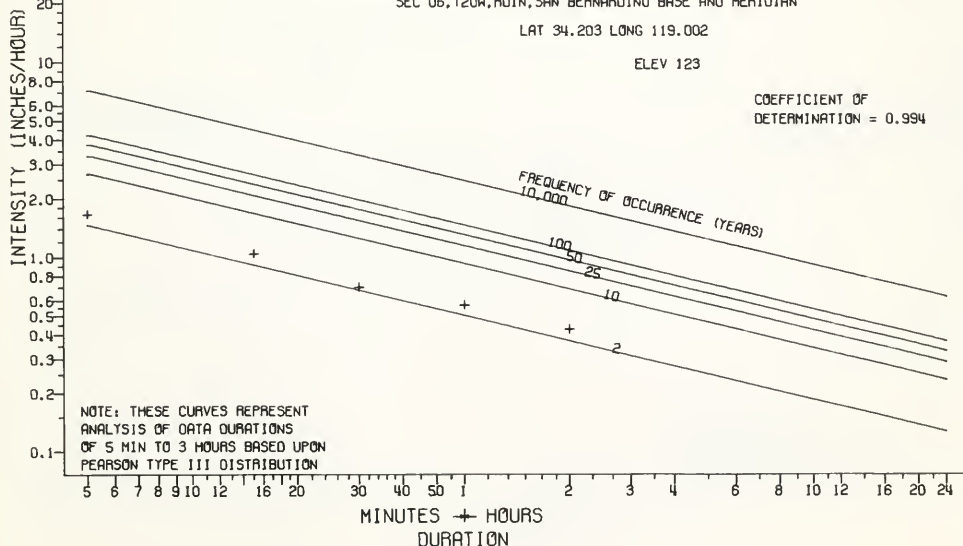
INTENSITY DURATION FREQUENCY CURVES FOR 1957 - 1974  
CAMARILLO VC 194 STATION U03 1339 2  
VENTURA COUNTY

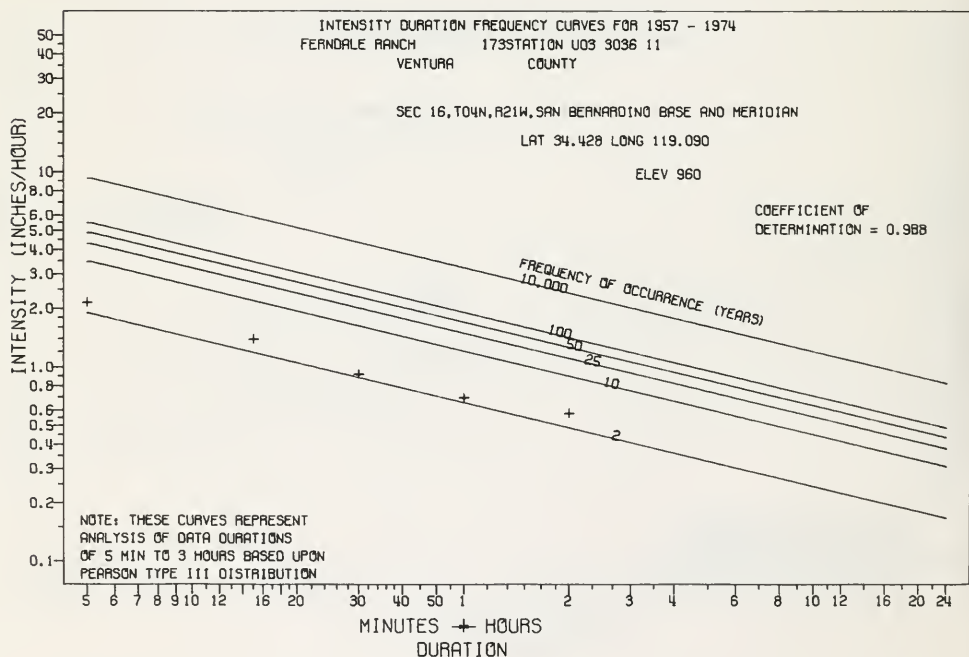
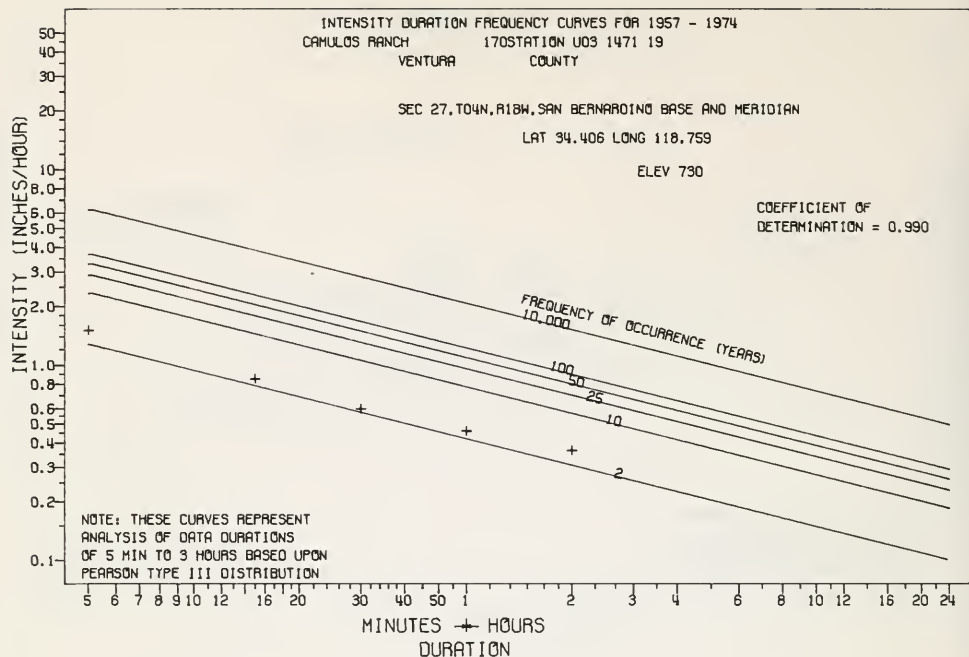
SEC 06, T20W, R01N, SAN BERNARDINO BASE AND MERIDIAN

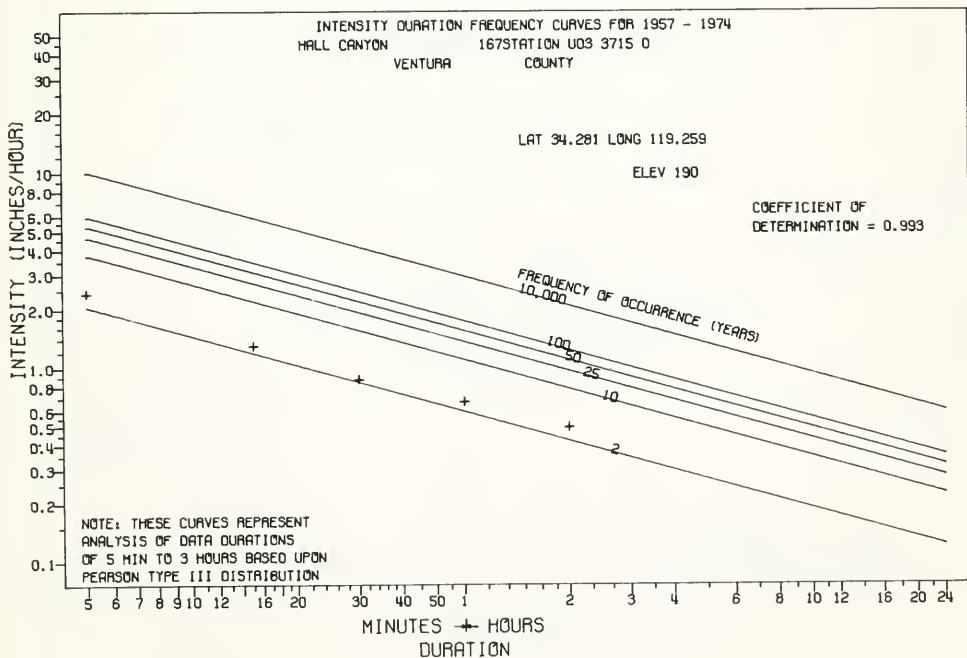
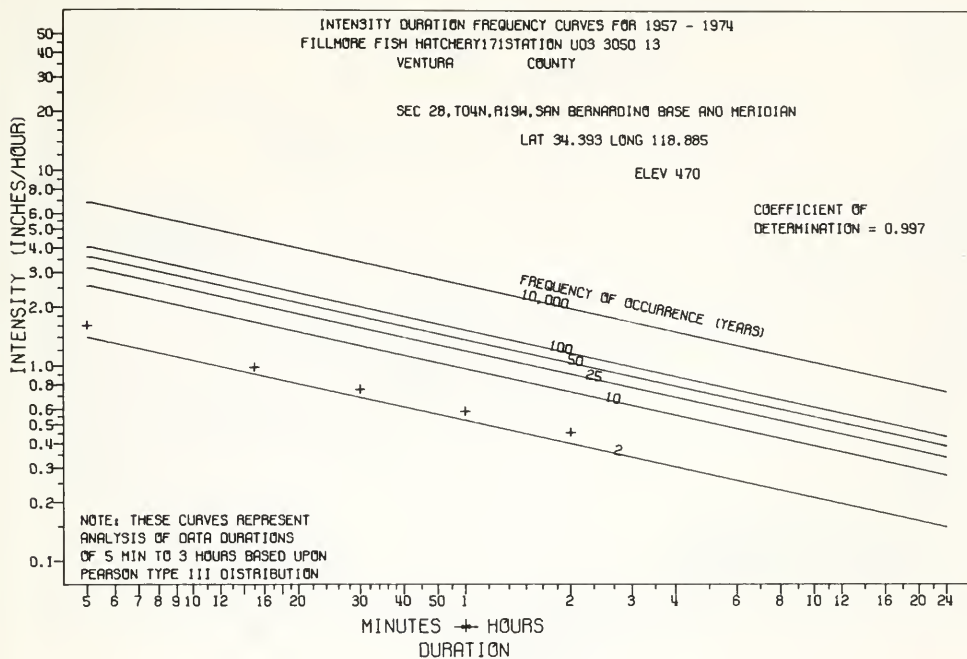
LAT 34.203 LONG 119.002

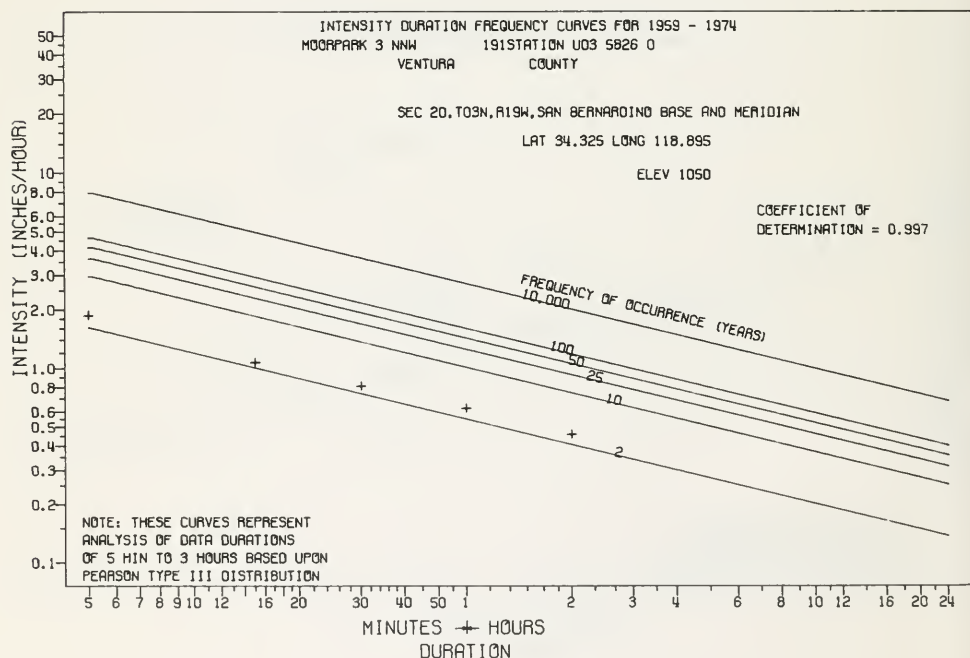
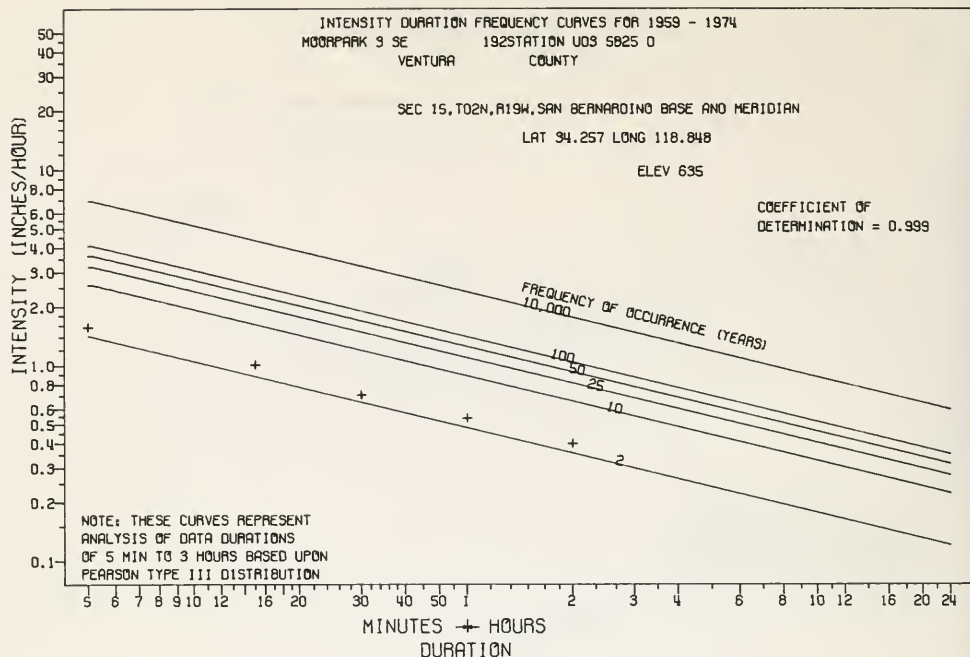
ELEV 123

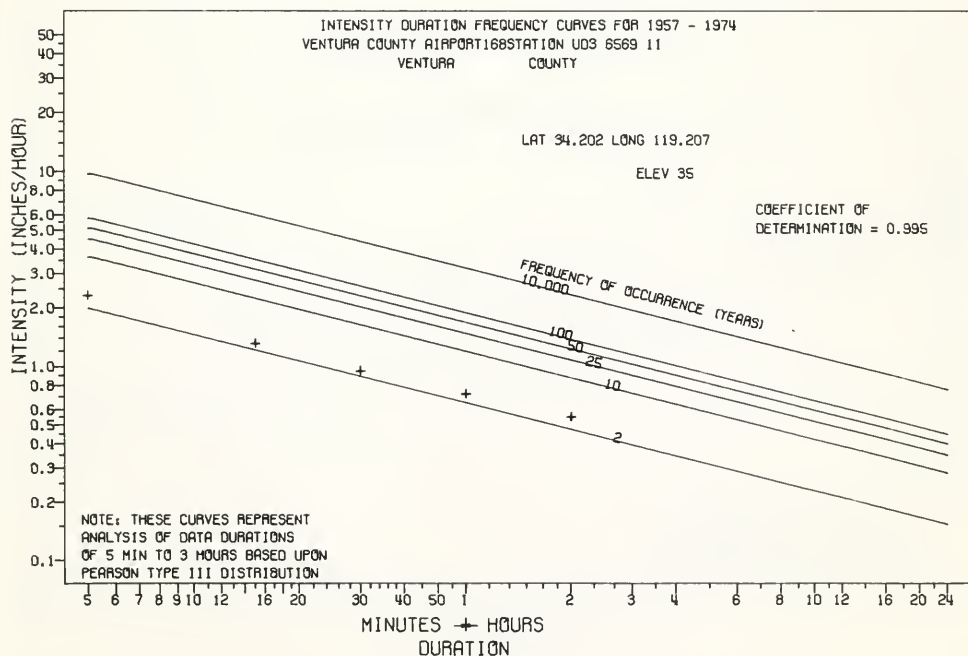
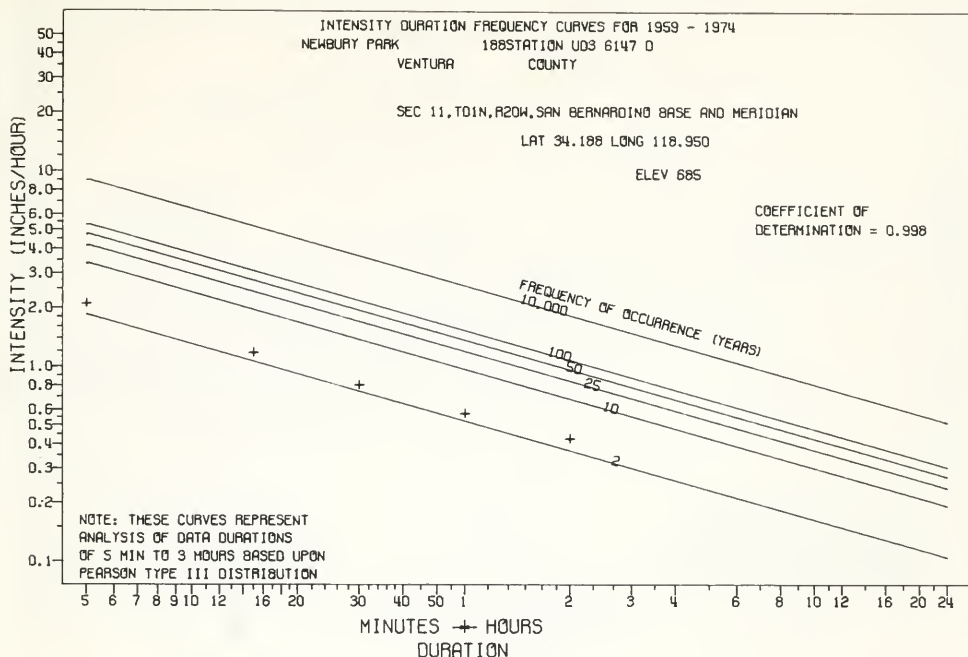
COEFFICIENT OF  
DETERMINATION = 0.994

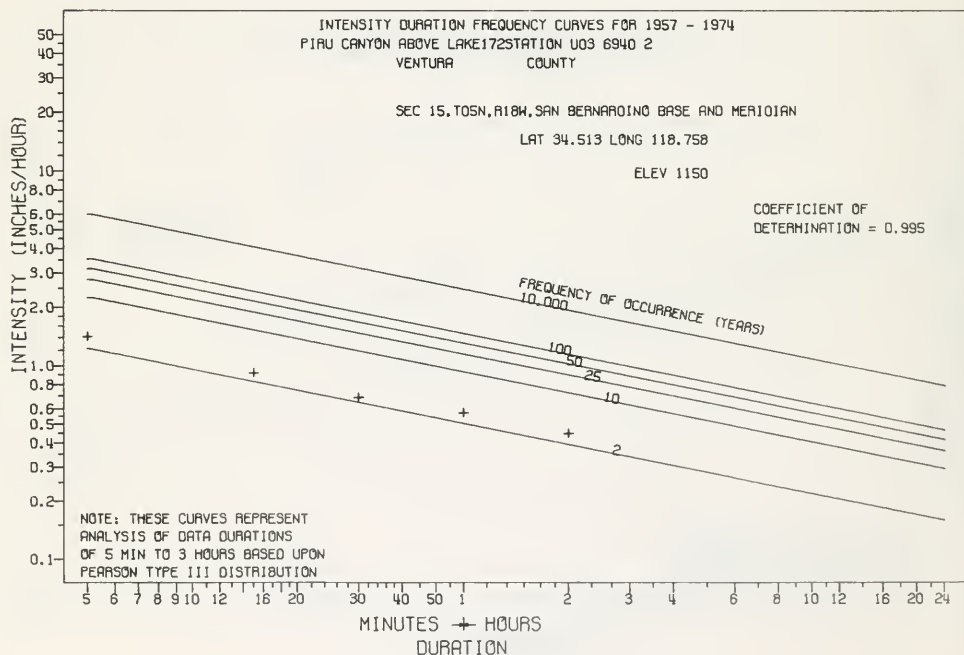
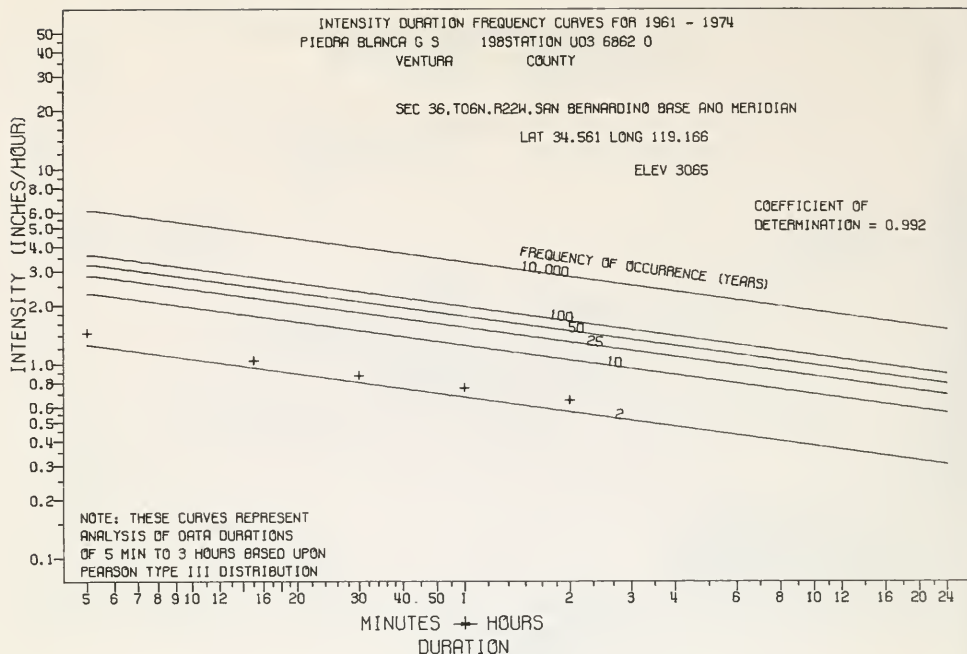


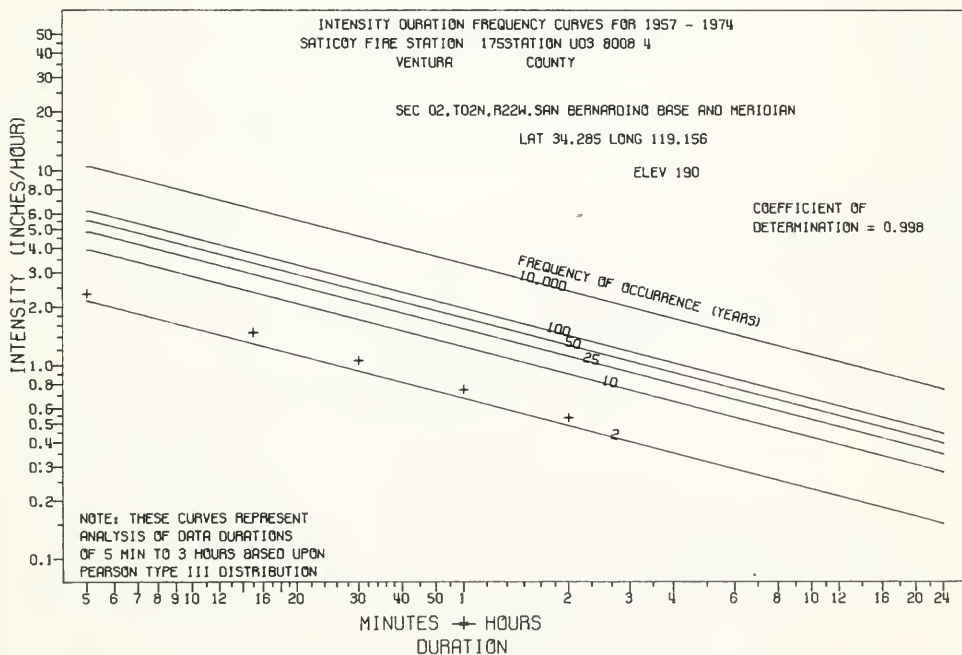
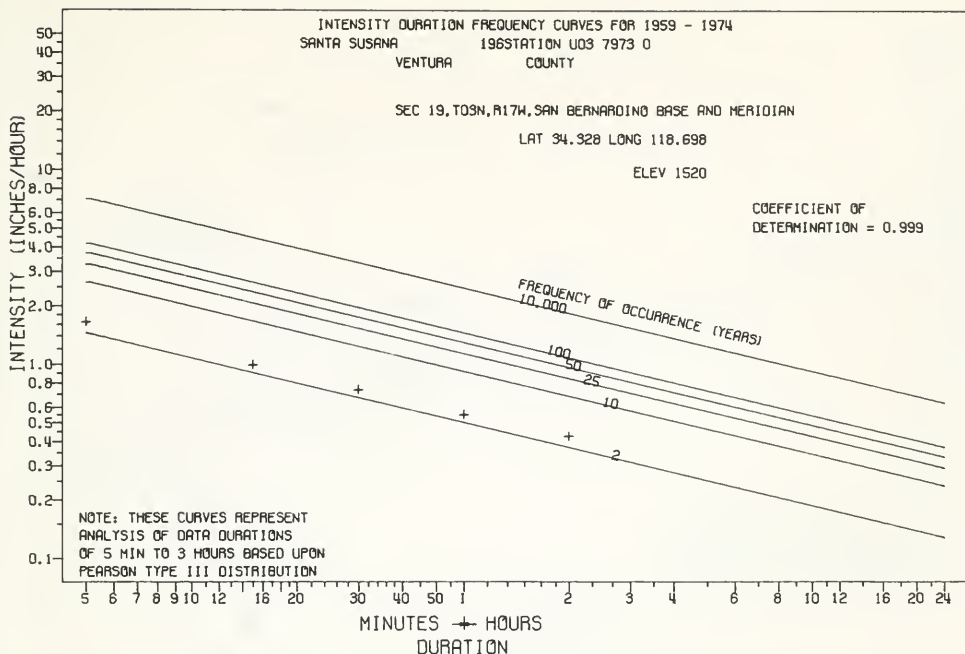




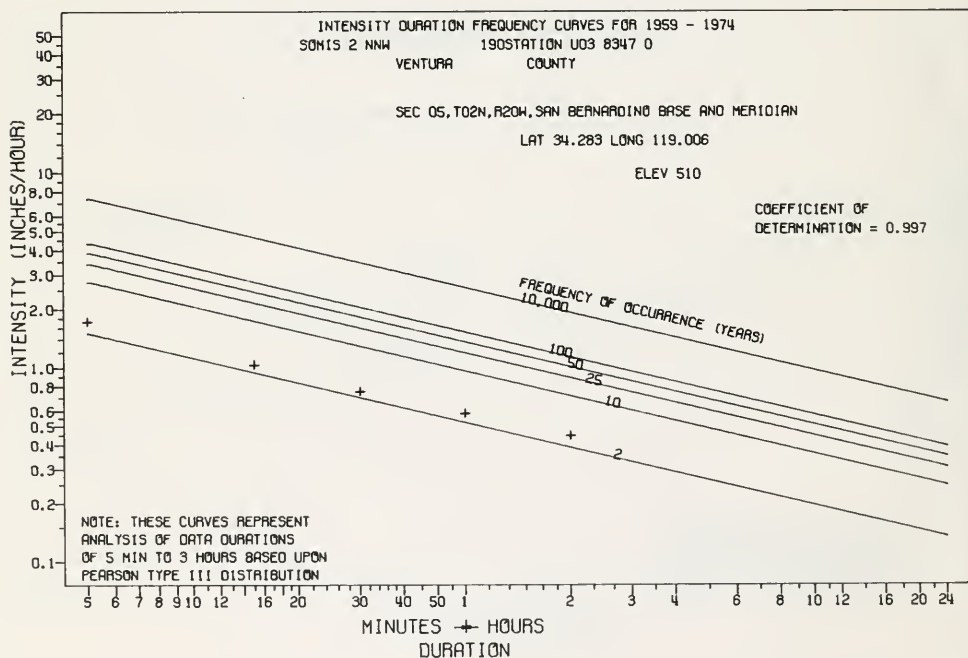
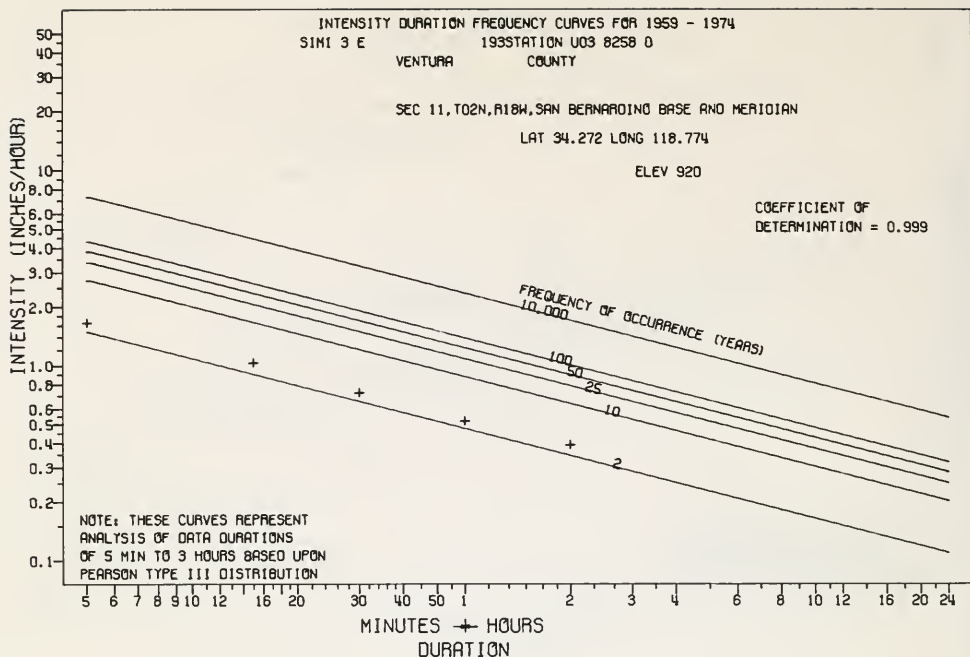




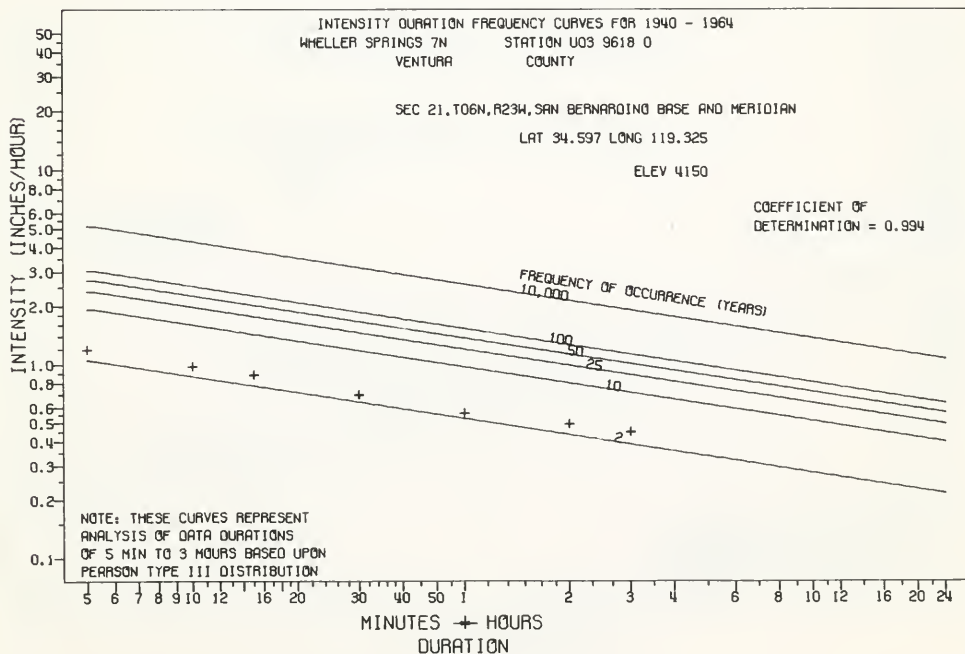
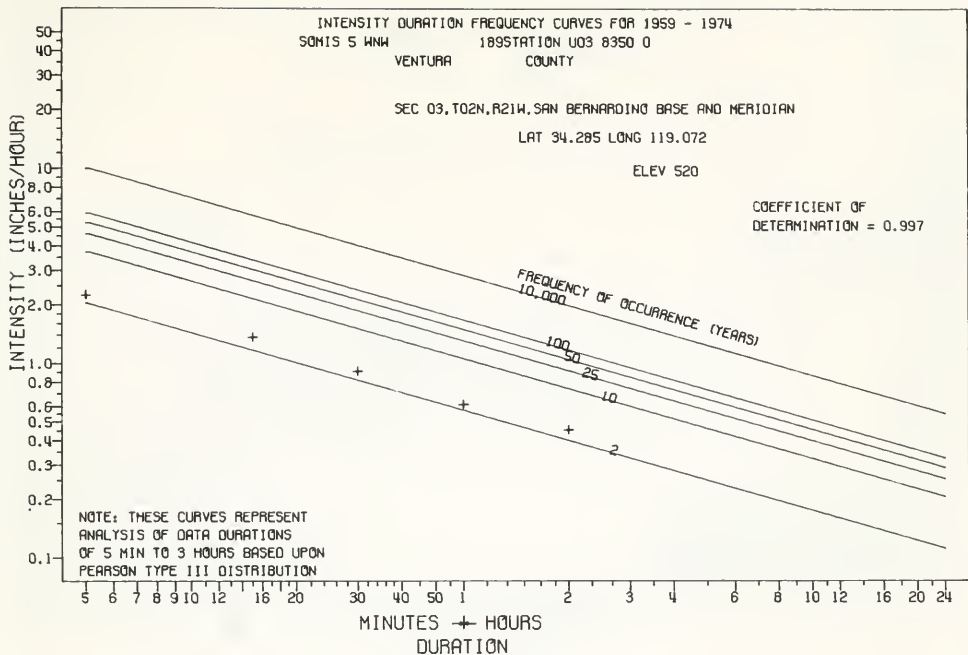


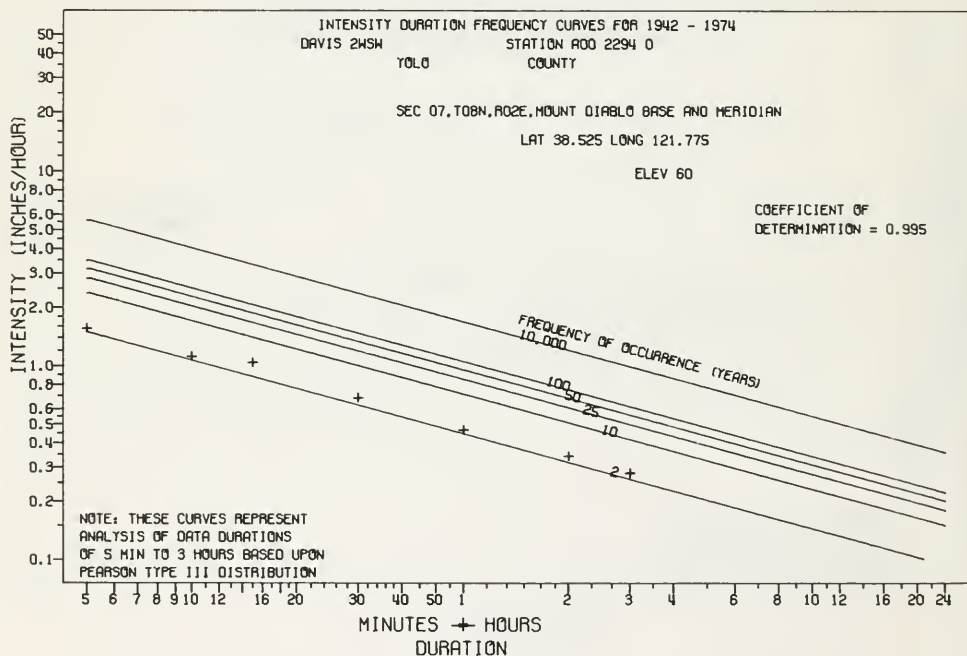
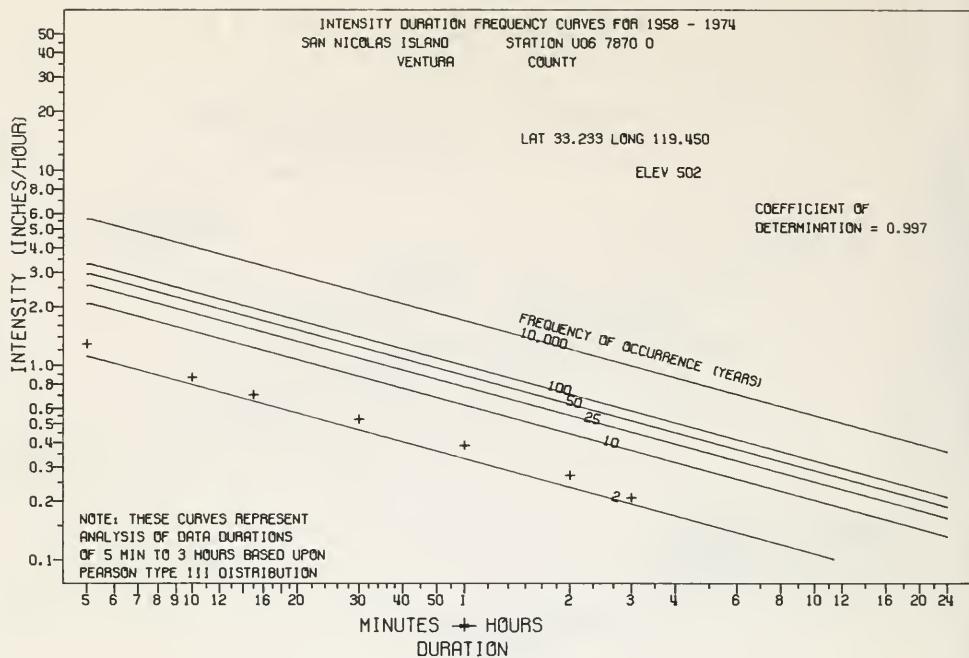


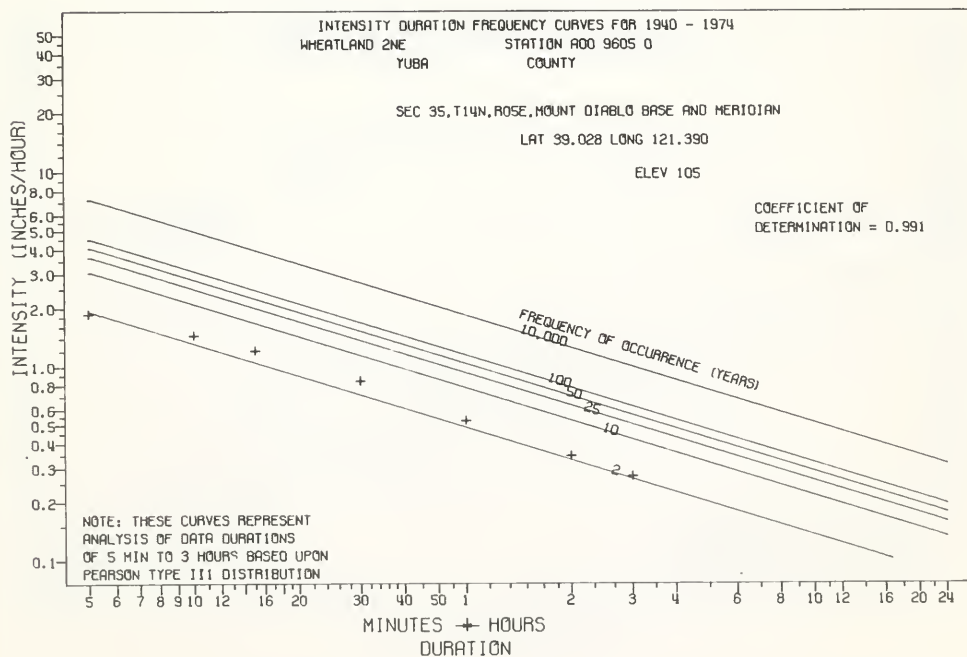
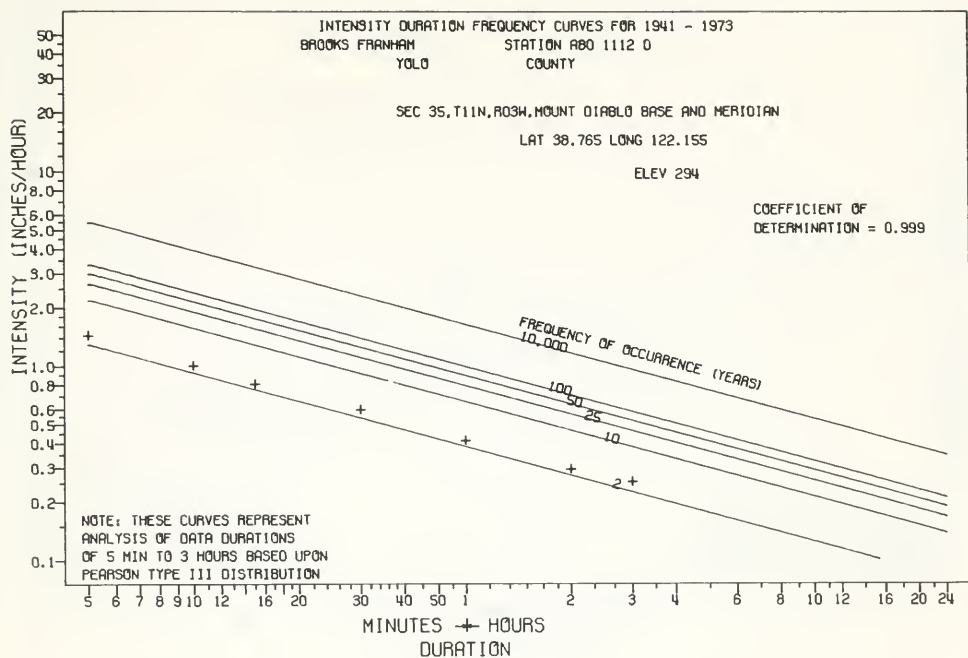


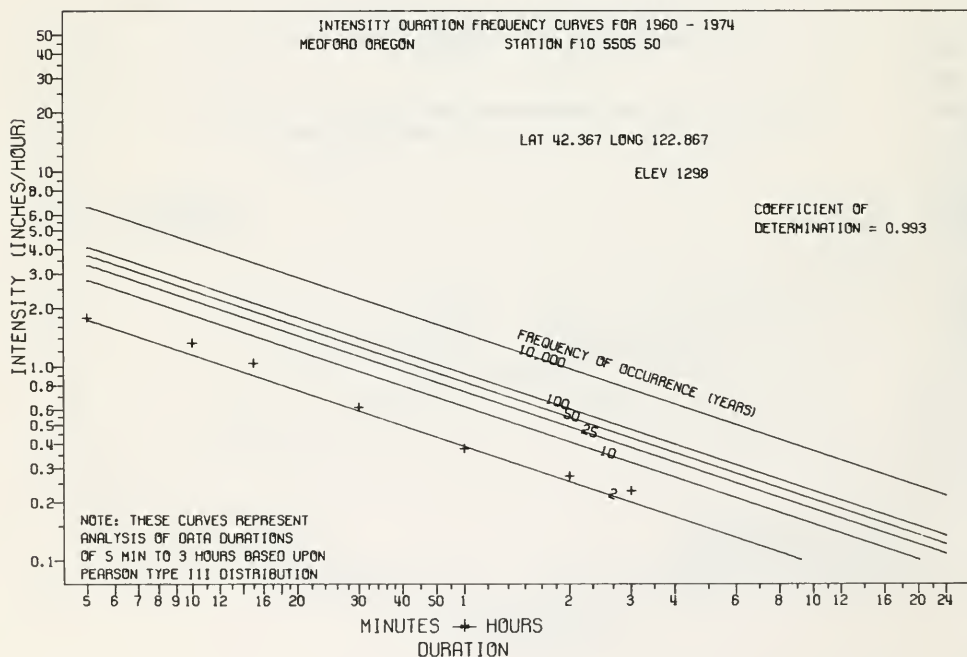
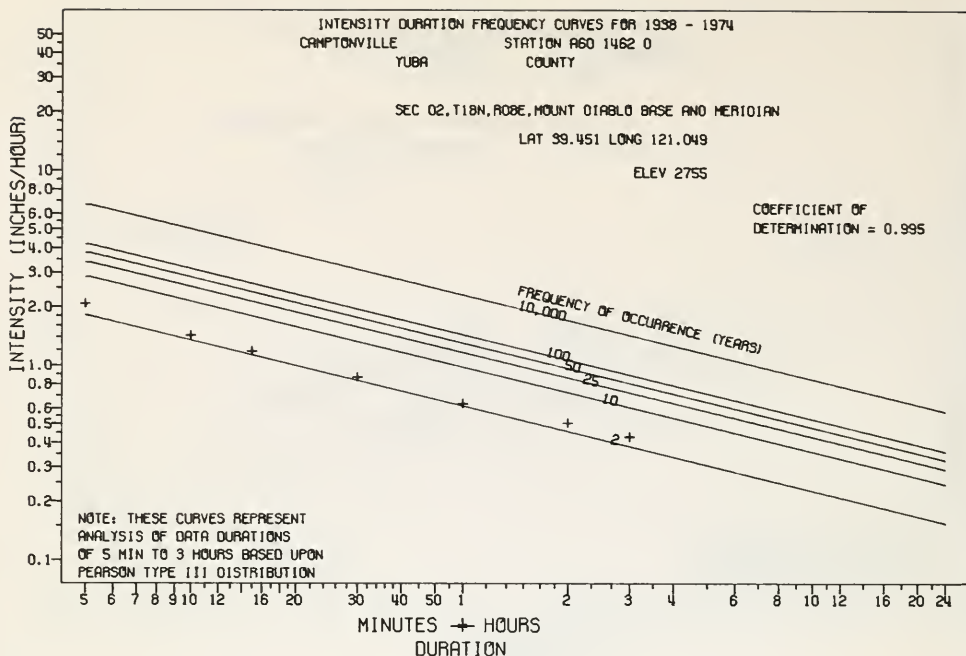


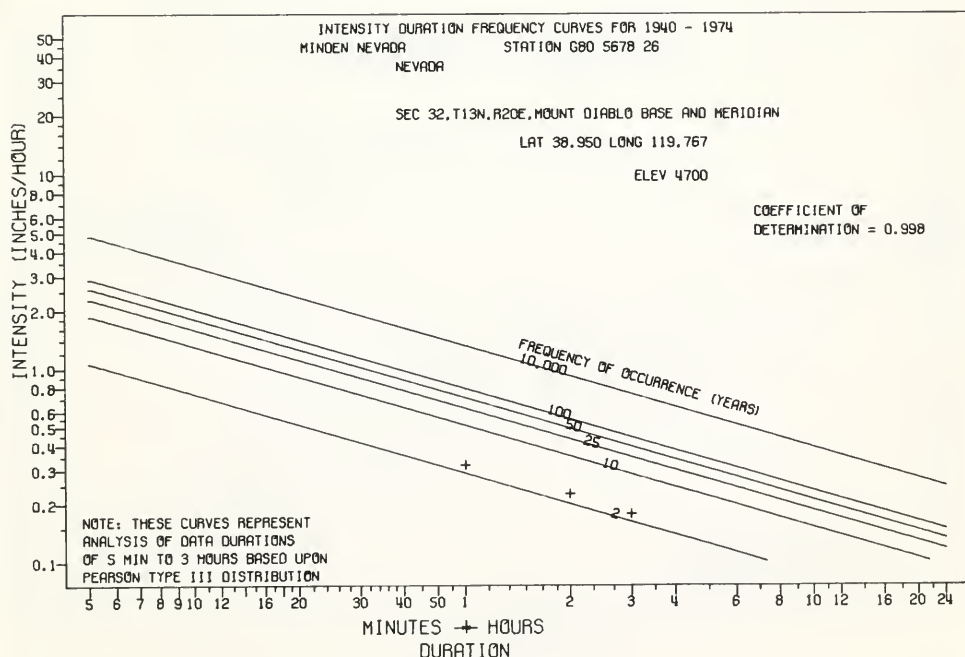
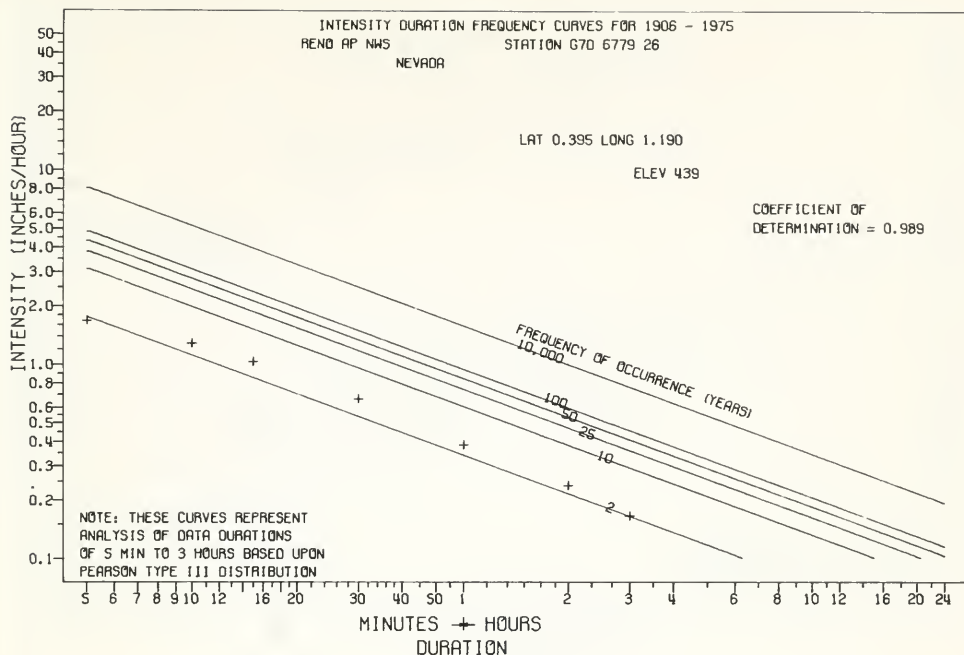


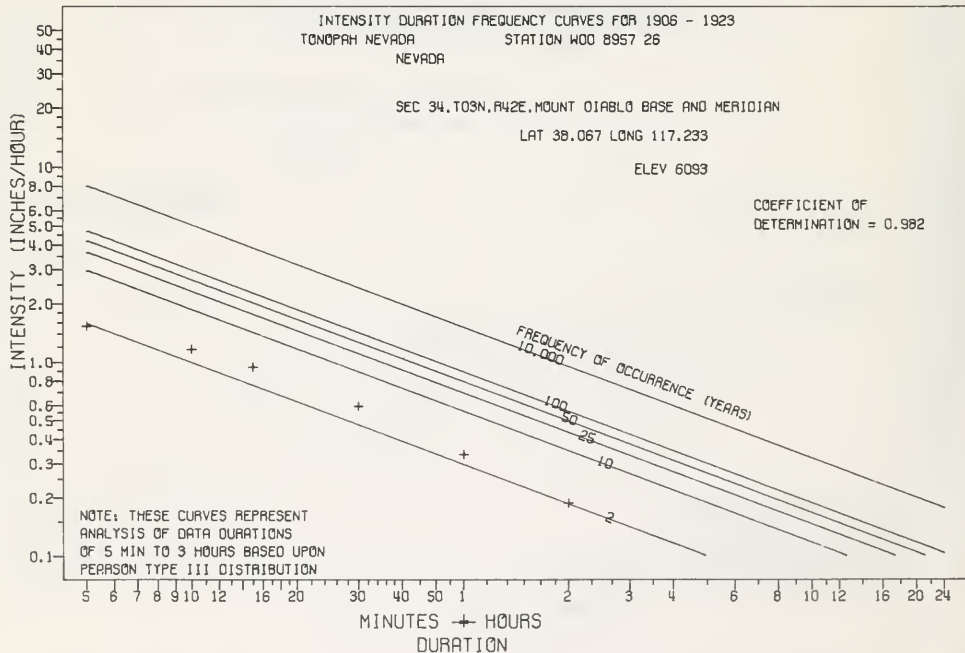
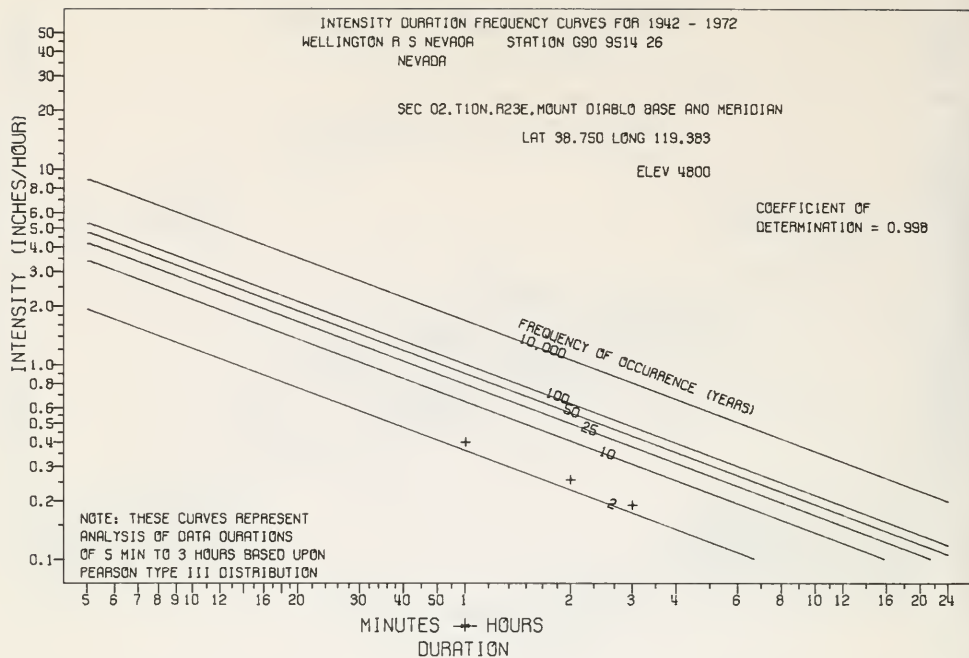


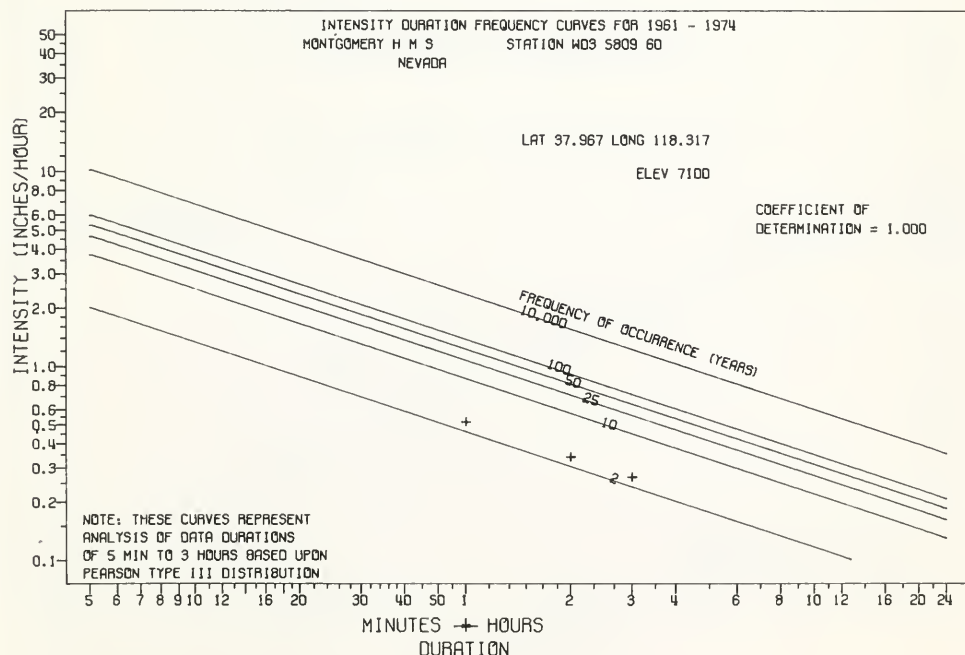
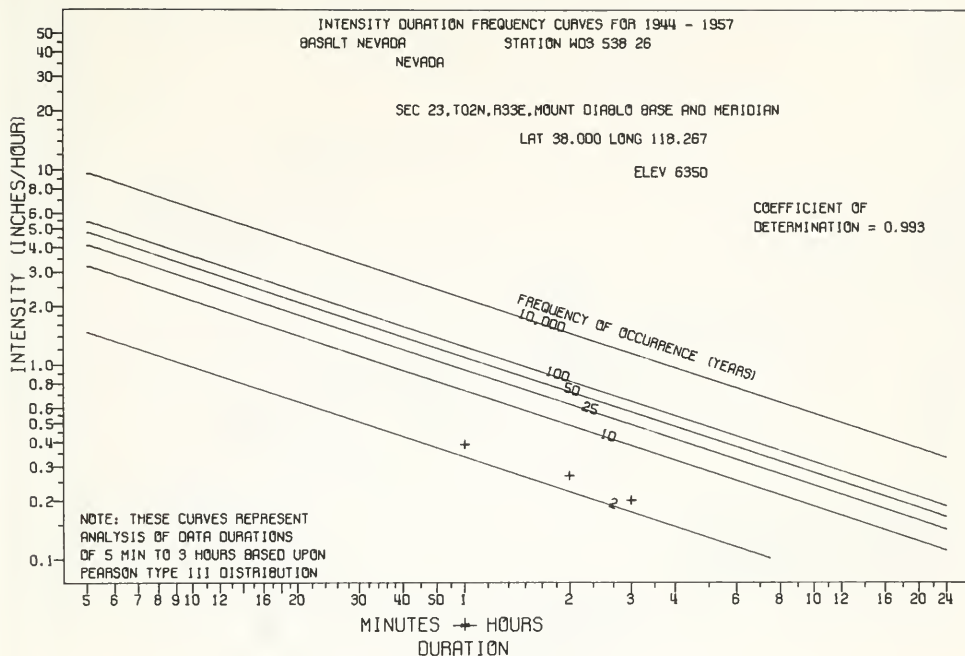




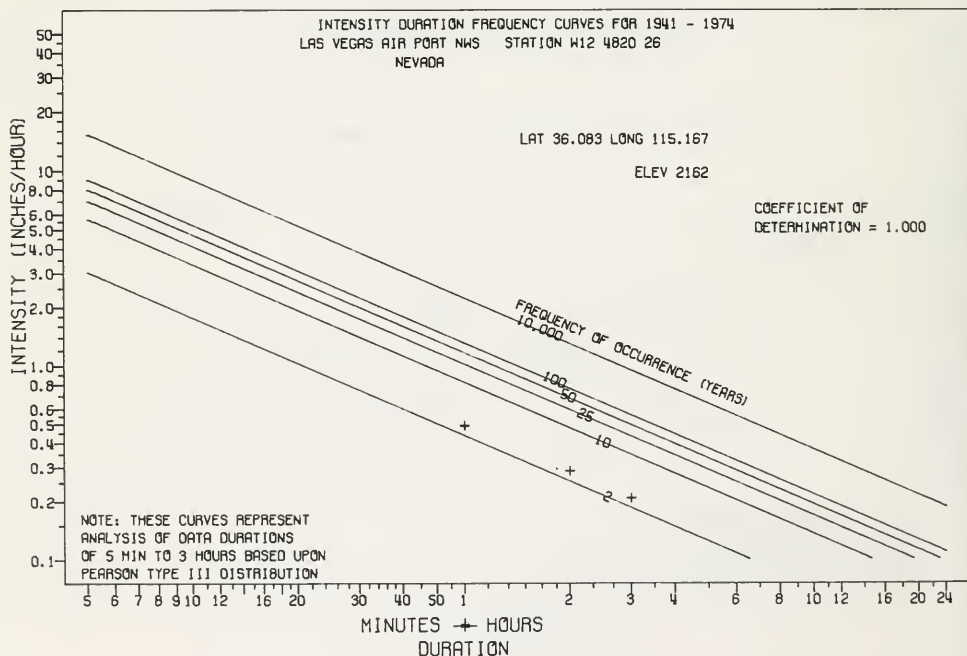
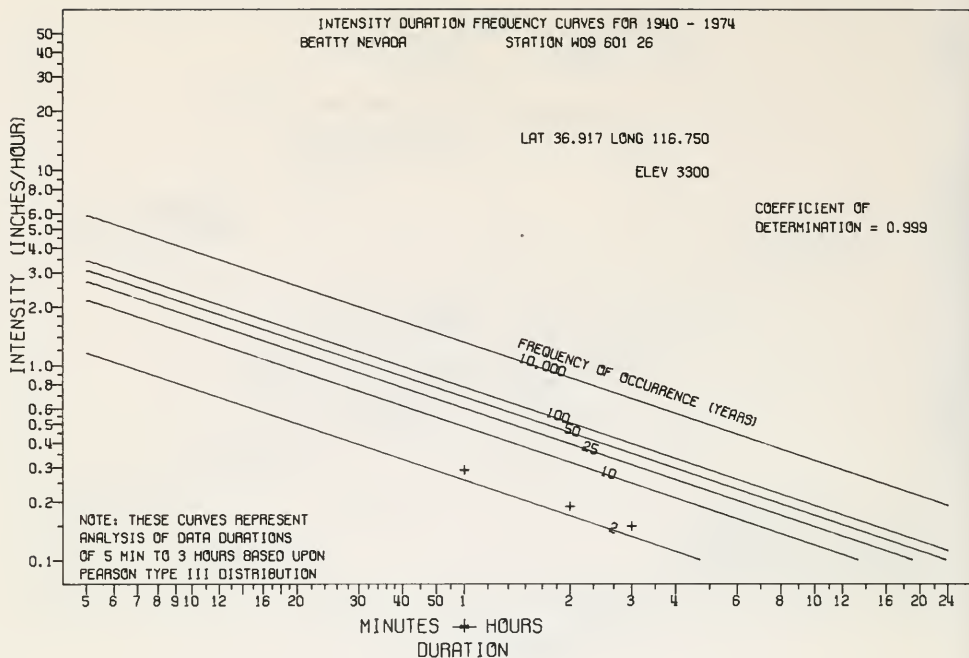




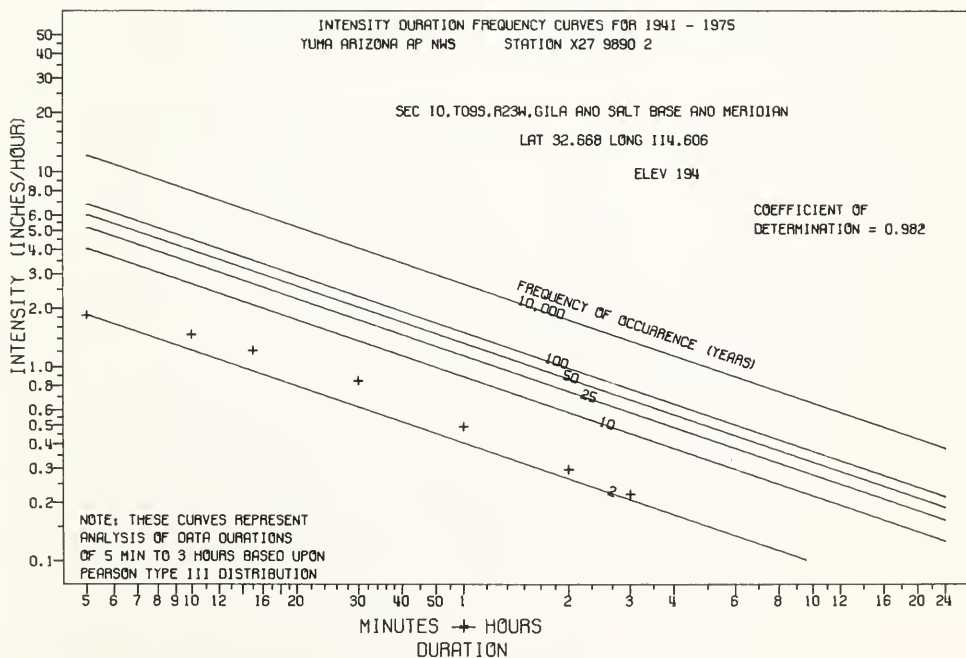
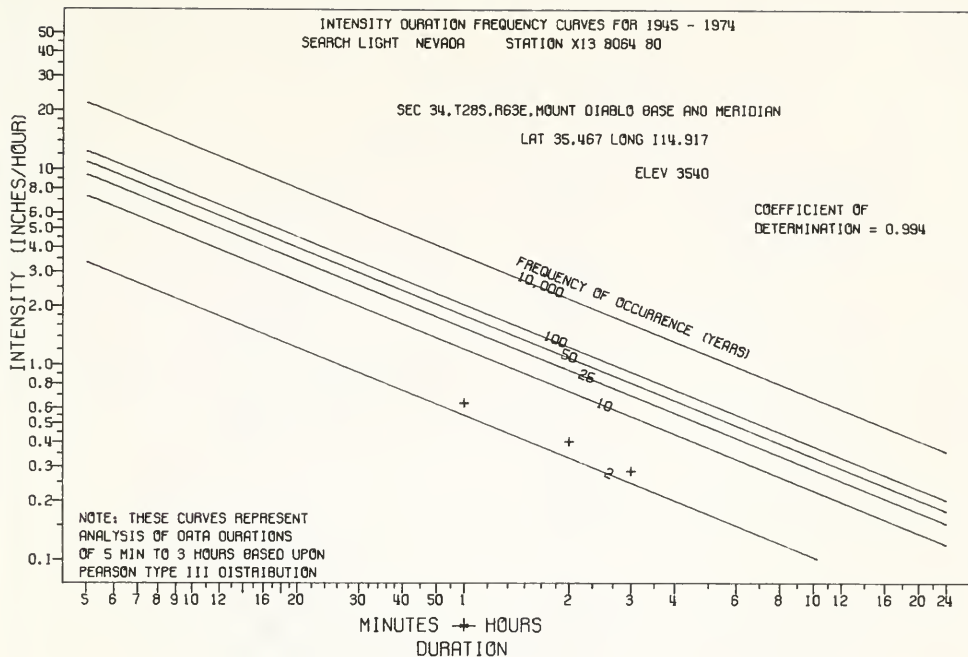














# CONVERSION FACTORS

## English to Metric System of Measurement

Quantity	English unit	Multiply by	To get metric equivalent
Length	inches (in)	25.4	millimetres (mm)
		.0254	metres (m)
	feet (ft)	.3048	metres (m)
	miles (mi)	1.6093	kilometres (km)
Area	square inches (in <sup>2</sup> )	$6.4516 \times 10^{-4}$	square metres (m <sup>2</sup> )
	square feet (ft <sup>2</sup> )	.092903	square metres (m <sup>2</sup> )
	acres	4046.9	square metres (m <sup>2</sup> )
		.40469	hectares (ha)
		.40469	square hectometres (hm <sup>2</sup> )
		.0040469	square kilometres (km <sup>2</sup> )
	square miles (mi <sup>2</sup> )	2.590	square kilometres (km <sup>2</sup> )
Volume	gallons (gal)	3.7854	litres (l)
		.0037854	cubic metres (m <sup>3</sup> )
	million gallons (10 <sup>6</sup> gal)	3785.4	cubic metres (m <sup>3</sup> )
	cubic feet (ft <sup>3</sup> )	.028317	cubic metres (m <sup>3</sup> )
	cubic yards (yd <sup>3</sup> )	.76455	cubic metres (m <sup>3</sup> )
	acre-feet (ac-ft)	1233.5	cubic metres (m <sup>3</sup> )
		.0012335	cubic hectometres (hm <sup>3</sup> )
		$1.233 \times 10^{-6}$	cubic kilometres (km <sup>3</sup> )
Volume/Time			
(Flow)	cubic feet per second (ft <sup>3</sup> /s)	28.317	litres per second (l/s)
		.028317	cubic metres per second (m <sup>3</sup> /s)
	gallons per minute (gal/min)	.06309	litres per second (l/s)
		$6.309 \times 10^{-5}$	cubic metres per second (m <sup>3</sup> /s)
	million gallons per day (mgd)	.043813	cubic metres per second (m <sup>3</sup> /s)
Mass	pounds (lb)	.45359	kilograms (kg)
	tons (short, 2,000 lb)	.90718	tonne (t)
		907.18	kilograms (kg)
Power	horsepower (hp)	0.7460	kilowatts (kW)
Pressure	pounds per square inch (psi)	6894.8	pascal (Pa)
Temperature	Degrees Fahrenheit (°F)	$\frac{t_F - 32}{1.8} = t_C$	Degrees Celsius (°C)









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